MORRIS ARBORETUM

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THE MORRIS ARBORETUM OF THE UNIVERSITY OF PENNSYLVANIA

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THE MORRIS FOUNDATION

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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TABLE OF CONTENTS

Photos: Olive Tree, page 8, by Ed Scanlon; others by Patricia Allison.

COVER: *Magnolia soulangiana* buds against the sky. A tutorial botany student at the Arboretum is studying their strong orientation toward the north-northeast.

THE WORLD'S MOST IMPORTANT TREES

J. J. WILLAMAN

Fig. 1. The tiny, starlike flower of the cacao tree is attached by a short peduncle to the main trunk of the tree. The fruit that develops from part of it may be six or seven inches long and four inches across. The flower is less than an inch across.

In the *India Rubber Journal* of some years ago there appeared the following: ". . . according to the *Dunlop Bulletin*, as quoted by the *Country Trader of Australia*, the American Society of Foresters published a list of ten trees in order of their long-term service to mankind and the degree to which the peoples of the world would suffer from their absence and the degree of their respective use. The date palm was ranked first, and unexpectedly the rubber tree (*Hevea brasiliensis* Mucll.-Arg.) was at the tail end of the list, which was as follows: 1) date palm, 2) coconut, 3) almond, 4) applc, 5) fig, 6) mulberry, 7) olive, 8) lemon, 9) cinchona (the sourcc of quinine), 10) rubber." Clearly, the subject is of intercontinental interest.

Now, such ratings are based largely on subjective judgments, backcd to some cxtent by quantitative considerations; hence we are frec to indulgc in our own opinions and to raise qucstions. For examplc, why, in 1943 (date of the *India Rubber Journal* article), was Almond rated so high and the source of quinine so low? Because nearly 30 years have elapsed, we thought it might be useful to examine the subject again.

In evaluating a species of trce and its product we gave consideration to thc number of people who use it; the number of people who grow it; its critical nced in industry, medicine, human and animal nutrition; number of years in use; degrcc to which substitutes could bc uscd; how widespread in the world it is; number of columns givcn to it in the *Encyclopedia Britannica* (EB, copyright 1972) and in the *Encyclopedia Americana* (EA, copyright 1971). This last may seem strange until we realize that, in thesc cncyclopedias, professional editorial committees of high expertise evaluate space against importancc of any topic. Here is our list in decreasing ordcr of importancc. 1) Tea, 2) Coffcc, 3) Rubber, 4) Cinchona, 5) Coconut, 6) Cacao, 7) Apple, 8) Olive, 9) Date, 10) Mulbcrry.

Fig. 2. The tea plant, *Camellia sinensis*, at the Morris Arboretum blooms in October.

TEA

EB gives it 7 columns, EA 6.5. *Camellia sinensis* (L.) Kuntze (*Thea sinensis* L.) is a small tree, kept to shrub size for convenience. EB says: "Tea is consumed as either a hot or a cold drink by about one-half of the world's population, yet it is second to coffee in commercial importance largely because a significant portion of the world's crop is consumed in the growing regions." The tea that reaches the markets totals some 1300 million pounds. Tea drinking began about 350 BC in China—over two millenia ago, with no signs of a decrease. Consumption per person is 10 pounds a year in the United Kingdom, 7 to 8 pounds in Australia and New Zealand, 3 in Canada, one-half in the United States. Figures aren't available for China and Japan, the highest consumers, or for Russia, where tea is drunk at all meals and at any other time of the day.

In South America the situation is different, where 15 million people drink maté, made from the leaves of a holly, *Ilex paraguariensis* St. Hil., which is cultivated there. Like tea and coffee, it contains the stimulating alkaloid, caffeine.

COFFEE

EB gives it 7 columns and EA 6.5. *Coffea arabica* L. is a small tree to 15 feet, but kept lower in plantations so that it can grow under the shade of taller trees. It first came to notice in ancient Ethiopia, first as food, then as drink. It spread to Yemen in the fourteenth century, to Mecca in the fifteenth. Cairo had coffee houses as early as 1511. Coffee is now consumed by about one-third of the world's population. In 1960, 26 countries grew and sent into world trade about 5600 million pounds. The United States alone used about a billion of those pounds. In some South American countries the growing and exporting of coffee looms large in the national economy, but is now endangered. The economy of Ceylon at one time depended wholly on coffee production. Then the Coffee Rust fungus wiped out the industry. Unfortunately, this same fungus was recently introduced into Brazil. It remains to be seen what will happen to the coffee-based economy of that country.

RUBBER

We deal here with natural rubber, of course. EB gives it 13 columns, and in one place it says that beginning in the nineteenth century, with the crudest manufacturing methods and equipment, the rubber industry has undergone continuous and dramatic changes to become one of the most complex industries of modern times and an indispensable part of all mechanical civilization. EA gives it 11 columns. The tree is *Hevea brasiliensis*. It is native to the Amazon Valley and for many decades rubber was an important article of export for Brazil. Then the plant was smuggled to Malaysia and was finally established in huge plantations there. At present it is also important in Indonesia, Thailand, Ceylon and Liberia. When synthetic rubber really got going in the nineteen-thirties, the natural rubber slumped badly for a while, but it was always in demand for certain products for which it was more suitable than the various synthetics. In fact, it still comprises 25 per cent of the weight of the rubber in tires. World production was hampered by the war in the southeast Pacific. But there then followed a steady increase: 1950, 1.8 million tons; 1960, 2.0; 1965, 2.3; 1968, 2.6; 1969, 2.9. Synthetic rubbers are, however, increasing faster. Very recently a chemical, called Ethrel in the trade, was discovered which, when injected into Rubber

trees, greatly increases the flow of latex. This puts natural rubber even more in the competition picture. *Hevea* is still a highly important tree to 165 million people in the plantation areas.

CINCHONA

The main source of quinine is *Cinchona ledgeriana* Moens. EB gives 1.8 columns to the tree, 1.1 columns to quinine, and 7 columns to malaria. In 1955 there were 250 million cases with 2.5 million deaths. The bark of the tree yields quinine and for a long time it was our only weapon against malaria. Then the synthetic Plasmochin, Atabrine, Chloroquine, Chlorguanine, Primaquine, and Pyrimethamine were successfully used in the treatment of the various forms of malaria and the need for quinine declined. Modern medicine became hopeful that it could make big advances against that ubiquitous, devastating disease. Then, to quote EB: "During the 1960's several strains of the malaria parasite, *Plasmodium falciparum*, developed resistance to the synthetic drugs, particularly the highly valued Chloroquine. The parasite remainced sensitive, however, to quinine, which had to be reinstated in various parts of the world in spite of effects which sometimes occur when the necessarily massive doses of quinine are given."

About this same time the furor against DDT arose. Its use was decreased in various regions and immediately the number of new malarial cases increased. We can't predict the outcome of this impasse, but we feel that quinine, and hence the Cinchona tree, is still a highly important element in civilization. To quote again from EB: "As á specific for this disease (malaria), quinine has benefited more people than any drug ever used for the treatment of infectious diseases. The treatment of malaria with quinine marked the first successful use of a chemical compound in combating an infectious disease."

COCONUT

EB gives 1.2 columns to *Cocos nucifera* L. and 2 columns to copra, the product of its fruit. EA gives 1.3 and 0.3 columns to these. This palm is grown extensively throughout Indonesia and the Philippines, where several hundred million people use the fruit for food; the milk for drink; fiber from the husk for ropes, baskets and brushes; fermented sap from the flower stalk as a beverage; leaves for thatch; trunks for structural timber and cabinet wood. And besides all this, they dry the fruit to copra. This is shipped to other millions of people for food and for extraction of over a million tons of oil yearly. The United States alone imports 250,000 tons of copra annually. EA says: "Coconut palms are probably the most important trees in the tropics. Many Pacific islands would be uninhabitable without them." In recent decades, a killing disease called Cadang-cadang has been attacking the trees.

CACAO

Cocoa comes from *Theobroma cacao* L. It has 4 columns in EB and 3 in EA. The world produces 1.5 million tons of beans per year, two-thirds of it in Africa, one-third in Venezuela and Mexico. It is the main source of income for the majority of people in Ghana. Hill, in *Economic Botany*, says that it is food and drink for 300 million people. It was food and drink also to the pre-Columbian Mayas and Aztecs. The Spaniards took it home with them and kept it secret from other countries for a hundred years. The Dutch devised a process of pressing out the oil to give

Fig. 3. Near-ripe coffee fruits. The bright red fruits follow fragrant white flowers, and are handsome against the dark, glossy foliage.

Fig. 4. Both Coconut and Banana trees border this grassy swale on a farm near the Mexico-Guatemala border.

cocoa butter. The residual cake, when ground fine is cocoa powder. The drink "cocoa" is made from this powder, sugar and milk, but in Latin American countries hot, liquid chocolate is made directly from freshly ground whole beans. In making chocolate candy, some extra cocoa butter, sugar and milk are added to the ground whole bean. Because there is a great deal of hand labor in growing, harvesting and processing the beans for market, this plant is of great economic value to the regions where it is grown. The high, and pleasant, nutritive value of chocolate made it an important part of the soldiers' diet in the Boer War, and World Wars I and II, especially in the United States Field Ration D in World War II. Ecuador at one time was the world's leader in highest quality cacao production. Two disastrous fungal diseases toppled the country from that position in a very short time. A long-term breeding program is underway for resistant varieties that will also produce beans of the same superior flavor as before.

APPLE

The tree is *Malus sylvestris* Mill. But is our common apple really among the big ten? In our opinion it is, for these considerations. EB gives it 4.5 columns, EA 8. It originated in southwest Asia. In the third century BC Cato already recognized seven varieties. It is economically and nutritionally important in 18 countries throughout Europe, USSR, the United Kingdom, United States, Japan, Korea, Argentina, Chile, Australia, and New Zealand. These countries produce 700 million bushels annually. In Europe it yields apple wine, in England called cider. Other by-products are vinegar, pectin, apple butter. The wood is still the first choice for tool handles. And after all, how could the United States have developed as it did without apple pie?

OLIVE

The Olive tree is *Olea europaea* L. EB gives it 5 columns, EA 2.6. It is grown almost exclusively in the area around the Mediterranean Sea. Here about 208 million people in 12 countries produce a million tons of olive oil, but export only 5 per cent of it. It thus ranks high in the diet of these populations. The olive tree is of record in the area since 3000 BC—5 millenia! Special varieties have been developed for oil production, with oil content in the fruit of 20 to 30 per cent. The amount of fruit eaten as such is minor compared with the oil. The old Assyrians were always warring on somebody and one of their favorite ways of weakening the enemy was to destroy his olive groves.

DATE PALM

This palm is *Phoenix dactylifera* L. EB allots 1.2 columns and EA one. The statistics for this plant and its fruit are of less magnitude than for those above, but the date palm is of the greatest importance in the very dry regions of North Africa and the Middle East. Sixty-four million people in the former and 80 million in the latter use dates as a staple food. Iraq supplies most of the dates of commerce.

MULBERRY

The Mulberry tree used for worm fodder is mostly *Morus alba* L. EB uses 14 columns and EA 8. As we are giving it only tenth place, some explan-

ations are in order. Silk has had an exhalted position in the civilized world for centuries. It stood high in the wealth of the Orient and in the commerce of the world. The fabric was not only beautiful, but strong; because it was expensive, it imparted status. In terms of the long centuries during which this was so, the switch to nylon and the other "—on" fabrics was only yesterday; nor have we yet discarded silk. In millions of pounds, world production of silk was 1476 in 1928, 142 in 1934, 119 in 1940, 42 in 1950, 68 in 1960, 71 in 1967. Thus, since the big decline, production has leveled off to some 60 million pounds a year.

During the last half of the nineteenth century, North America received a cataclysmic by-product of the love of silk. Because Mulberry grows well here, another efficient silk-making moth was introduced in hopes that a new industry might be established. This was the Gypsy Moth that escaped into our forests and even now threatens the very existence of deciduous trees over vast areas.

Nevertheless, there has always been a fascination about silk during the pinnacle of its popularity: the continuous and voracious appetites of the moth larvae for the Mulberry leaves, the spinning of the cocoons, the killing of the larvae, the winding of the thread, the fabric weaving and treatment and weighting with size, and the dyeing and printing. Then the silk went as cargo on the beautiful clipper ships, possibly with pirates lurking about, and wound up on "the best people" as dresses, shirts and stockings. In spite of what modern chemistry has done to replace silk we feel Mulberry still has a place in our ten, even though it just makes the grade.

It may be of use to consider briefly the three trees included in the article by the American Society of Foresters but excluded here—lemon, almond and fig.

LEMON

The tree is *Citrus limon* L. Lemon has 5 columns in EB and 1.3 in EA. World production of the fruit was 1.6 million long tons in 1965. California and Italy produce two-thirds of this. Lesser producers are Spain, Turkey, Greece, Argentina, Chile, Lebanon, Israel, Australia, Tunisia, and Algeria. Southern California with its 15 million 40-pound boxes per year is the only place where it looms as even a local crop of high importance. Its products are frozen juice, pectin, lemon oil and citric acid.

Fig. 5. A refreshing drink of milk from a freshly cut immature coconut fruit is enjoyed by Dr. John M. Fogg, former director of the Arboretum.

ALMOND

The tree is *Prunus amygdalus* Batsch. The nut is given 1.2 columns in EB and one in EA. The almond has been in cultivation for many centuries. It is important among the nuts of commerce, but it can be considered a substantial article of food only in the restricted regions of its growth. Otherwise they are just delectable pleasures. The US produces about 80,000 tons annually.

FIG

Ficus carica L. is the tree. It is given 3.5 columns in EB and 2 in EA. Apparently statistics are scarce, as we find only that the United States crop in Texas and California is about 4 million dollars per year. In the Old World figs are grown commercially, but not in large amounts in Italy, Turkey, Algeria, Greece, Portugal and Spain. The fig has always been a

Fig. 6. The Olive Tree is everything to many inhabitants of the Mediterranean area where use is made of every part. This one grows in the Garden of Gethsemane.

staple in the Mediterranean countries and is still known there as the "poor man's food."

OTHER ENTRIES

There are several other trees that readers might ask about for inclusion in this discussion. Two of them are the Cork Oak and bamboo.

Cork comes from the bark of the Cork Oak, *Quercus suber* L. It is grown largely in Spain. The remarkable thing is that the bark is stripped off completely around the tree at a special cork cambium layer. This not only does not kill the tree but in the course of some 6 or 8 years the bark has regrown and can be stripped again. EB discusses it in 1.5 columns and EA in 2. In the latter, at the end of the article prepared by R. L. Acklin of the Armstrong Cork Co. of the US, it says: "Because of high costs, however, cork is being supplemented by less expensive and newer materials. Fiberglass has practically replaced cork for insulating refrigerators, and fiberboard is used extensively for sound insulation. In the United States, moreover, metal and plastic screw caps have virtually replaced the cork bottle stopper, one of the most ancient of cork products."

The giant tree-like grasses known as "bamboo" are of great local use where grown—southeast Asia, India, Japan, China, Madagascar, South America. Bamboo is used for paper, food, furniture, flooring, scaffolding, shelter, tools, protection, and plumbing around homes and villages. In world trade it has limited value, except, of course, to many generations of young anglers. Also, because the word bamboo covers five genera and many species of plants, it would hardly fit into our present discussion.

What are your feelings in the matter? Should the list of criteria be enlarged? Is commercial production a true index of importance? Should we draw up a list for modern times and another for ancient times? After all, the great timbers of the Mediterranean were nearly made extinct in the building of vast navies, in the erection of cities, in the production of energy—ultimately in the founding of our own civilization. Finding and evaluating potential candidates for our Top Ten Trees is most instructive. Have we slipped up on Banana?

Announcements for Associates

SPRING SHORT COURSES

Announcements of the Spring series of courses on basic botany and practical horticulture designed for the Associates of the Arboretum and the general public were sent out early in 1972. Each course consists of six sessions of 90 minutes each (with a short recess midway), and combines lectures, demonstrations and practical experiences. Classes meet in Gates Hall on Meadowbrook Avenue. The registration fee is $25 per course for Associates, $30 for others. Note that the basic course will be offered in the evening this Spring so that persons busy during the day may attend.

11. CONIFERS. DR. H. L. LI.
Distinctive features and means of identifying the genera and species of these remarkable cone-bearing plants.
Mondays, 10-11:30 a.m., March 27, April 3, 10, 17, 24, May 1.

01. ORGANIZATION AND FUNCTION OF PLANTS. DR. A. O. DAHL.
An introduction to the structure of flowering plants; how roots, stems, and leaves, flowers, fruits and seeds function; and how the plants live in their environment. This course, or equivalent knowledge, is needed for most other courses.
Mondays, 8-9:30 p.m., March 27, April 3, 10, 17, 24, May 1.

02. CLASSIFICATION AND IDENTIFICATION OF PLANTS. DR. A. E. SCHUYLER, Philadelphia Academy of Natural Sciences.
General principles of classifying and naming flowering plants; ways of identifying plants by using keys, manuals, floras, and the herbarium.
Tuesdays, 10-11:30 a.m., March 28, April 4, 11, 18, 25, May 2.

04. PLANT PROPAGATION. WILLIAM BRIENTNALL.
Basic procedures of propagation by seed and vegetative parts. Particular attention will be paid to those plants which can be propagated during the Spring and Summer months.
Wednesdays, 10-11:30 a.m., March 29, April 5, 12, 19, 26, May 3.

03. MOLDS, MUSHROOMS, AND THE ENVIRONMENT. DR. PATRICIA ALLISON.
What important fungi look like; how they interact with their surroundings and change the lives of other creatures.
Thursdays, 10-11:30 a.m., March 30, April 6, 13, 20, 27, May 4.

LAURA L. BARNES LECTURE

The tenth annual lecture commemorating Dr. Laura L. Barnes will be given on Thursday, April 27. Dr. Ian McHarg, renowned chairman of the Department of Landscape Architecture and Regional Planning at the University of Pennsylvania will be the speaker. The lecture will be at 8:30 p.m. at the Woodmere Art Gallery in Chestnut Hill. Separate announcements will be mailed.

PLANT DISTRIBUTION DAYS

The plant distribution days for 1972 will be on May 19 and 20. As in the past, separate announcements will be mailed to Associates.

POST CARDS

Associates are reminded that several full color views of the Arboretum are available in the form of postal cards at the office.

ADVISORY BOARD MEMBER DIES

We are sorry to report that Harry E. Sprogell, a regular member of the Morris Arboretum Advisory Board of Managers died recently. His humane, constructive attitude toward justice, the law, and beauty permeated his many endeavors. He was an officer of the Pennsylvania Civil Liberties Union, the American Civil Liberties Union, and the Philadelphia Bar Association's Committee on Civil Rights. Mr. Sprogell served as president and trustee of the Philadelphia Yearly Meeting of the Religious Society of Friends, and helped the Society's efforts in other major ways.

A college (Wilmington, Ohio), a hospital (North Penn), an art gallery (The Woodmere), and an orchestra (The Philadelphia) all were recipients in one way or another of his attention as a board member.

NEW SUPERINTENDENT APPOINTED

We are very pleased to announce the appointment of Gerald B. Abrams as Superintendent of the Morris Arboretum.

Before coming to Philadelphia, Mr. Abrams was a member of the Horticulture Department of Purdue University, Lafayette, Indiana, where he was superintendent of the University Ornamental Horticultural Park and Arboretum.

Mr. Abrams is familiar with plants in the Philadelphia region. He was born in Wilmington, and earned his baccalaureate degree at the University of Delaware. During his undergraduate study he was the recipient of the National Association of Gardeners Scholarship. He also holds a Master of Science degree in plant science from the same institution where his special areas of interest were landscape design and nutrition of ornamental plants. He was awarded a research assistantship during his graduate studies.

In addition to experience in grounds maintenance and labor management, Mr. Abrams brings to the Morris Arboretum a background in teaching courses in practical horticulture and in cooperating with extension nursery specialists and research scientists. He is a member of the International Plant Propagators Society and of the American Society for Horticulture Science.

Mr. Abrams and his wife Marianne will reside at Bloomfield.

DR. DAHL RETURNS FROM LEAVE

Dr. A. O. Dahl returned to the Arboretum in January from his year of academic leave at the University of Stockholm, Sweden where he was Research Professor in the Palynological Laboratory which is included in the newly completed building of the Wallenberg Laboratories at Lilla Frescati.

The appointment made it possible for him to continue his researches on the electron microscopy of the development of pollen grains in a number of species, particularly in the families *Magnoliaceae* and *Ranunculaceae*. Recently, he was appointed to the Editorial Board of "World Pollen and Spore Flora," a long-term project having its headquarters in the Palynological Laboratories in Stockholm.

During the Spring term he is teaching Botany 200, Taxonomy of Flowering Plants, at Penn and Course 01, Organization and Function of Plants, at the Arboretum.

CHRISTMAS OPEN HOUSE

For the first time in many years the Arboretum had open house for its Associates and their friends. Downstairs, hot holiday wassail and ginger cookies were served in the library. Upstairs, there were displays of some of the activities of staff and students. Guests received gifts of recipes and also corsages and bouquets of Christmas greens and berries. Several dozen similar gifts were delivered to Chestnut Hill Hospital for staff and patients unable to leave for the holidays.

THANKS TO VOLUNTEERS

A number of generous volunteers helped with the Christmas Open House, various mailings, and other projects. The Arboretum is very grateful for this kind of much-needed assistance.

RARE TREE DOWN

We are sorry to report that the Arboretum's mature specimen of *Pinus griffithii zebrina* was lost during one of the recent wind storms. Arrangements were made with area nurserymen to salvage all the scions possible for grafting.

SOIL ACIDITY AND WINTER HARDINESS

EDGAR T. WHERRY

Since our current east-American agricultural-horticultural practices are largely based on those developed in southern Europe, where circumneutral soils prevail, this type of soil-reaction is widely favored. There are, however, a not inconsiderable number of plant species—notably members of the Heath Family, and many of our forest trees—which grow naturally on soils of acid reaction, and fail to thrive in neutral-soil gardens.

In the Morris Arboretum Bulletin Vol. 11, No. 1, p. 7, 1960, there appeared an article by Dr. Frank S. Santamour, Jr., on "Western and Southern Oaks in the Michaux Quercetum." From the response of 18 species it was concluded that "the evergreen or live oaks simply can not survive the rigorous winters in sufficient numbers to justify their use."

However, for many years the late Mrs. J. Norman Henry collected in the southwestern states various attractive species of more or less evergreen oaks and planted them in several different locations in the Henry Foundation garden, where they have grown for many years. This is located only about 7 miles southwest from the Morris Arboretum so the general climate is similar.

Soil-reaction tests suggested an explanation. The Michaux Quercetum was located in the only space then available at the Morris Arboretum, on the limestone plateau at its northeast corner, where the soils are predominantly circumneutral. The Henry Foundation is underlain by granitic rocks yielding more or less acid soils. Even though there are differences in slope and exposure between the two gardens, in my judgment the discrepancy can be resolved by adding 5 words to Dr. Santamour's summary: "when planted in circumneutral soil."

The better nourished a plant is, the more capable it is of resisting environmental stress, whether this be cold, parasites, or pollution. Soil acidity, by furnishing needed nutrients for plants adapted to it, thus does have a bearing on winter-hardiness.

Book Review

A FLORA OF TROPICAL FLORIDA by Robert W. Long and Olga Lakela. 1971. University of Miami Press, Coral Gables, Florida. 962 pages. $29.50.

A manual for the flora of southern Florida, the first of its kind, is now made available to botanists, horticulturists, naturalists, conservationists and others interested in plants. "A Flora of Tropical Florida, Manual of the Seed Plants and Ferns of Southern Peninsular Florida," by Robert W. Long and Olga Lakela is a well-prepared handbook that will prove to be useful to many people.

The book starts with an account of the "History of Botanical Collecting in Southern Florida" by Joseph Ewan, an introductory discourse on the geology, origin and composition of the flora, and plant communities. This is followed by "General Keys to Families of Vascular Plants" and the manual proper in which there are descriptions and diagnostic keys covering 179 families, 762 genera and 1647 species of flowering plants, gymnosperms, ferns, and fern allies. There are 125 full pages of line drawings illustrating important plant details.

The descriptions are concise and clear, and the keys are well arranged and presented. The illustrations are accurate and artistic. Altogether it is an excellent manual that should be on the shelf of all libraries and in the hands of everybody who is visiting the area or interested in its vegetation.

H. L. Li

NEW ASSOCIATES 1971

The Associates is an informal group of individuals who are interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum and to whom special privileges are extended. We are happy to welcome the following new members who joined in 1971.

Mr. M. Worth Acker
Mr. W. Stewart Alford
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MORRIS ARBORETUM

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TABLE OF CONTENTS

Photos: Cover, William Wright; p. 15, Angus Heeps; p. 16, John M. Fogg, Jr.; p. 17, Patricia Allison, John M. Fogg, Jr.; p. 19-23, A. J. Gilmartin; p. 25, courtesy of the artist.

COVER: *Aesculus parviflora* Walt., the Bottlebrush Buckeye, is a spreading shrub, native to the United States, that blooms in summer.

DISAPPEARING PLANT SPECIES

ARTHUR T. GUARD

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That our present day plants are not a total representation of the past flora of the world is obvious. Geology teaches us that this is an indisputable fact; however, this does not change the fact that many of us are anxious to prevent or delay the disappearance of our present day species. In order to work more effectively toward this end, it is necessary to know what causes plant species to fail in their struggle for survival. If we ask ourselves why some species disappeared, we find that the answers, in so far as they are known, are varied and complex. With this in mind, let us look at some of the species that have disappeared and some that seem to be definitely on their way out.

In the Petrified Forest National Monument in Arizona are the fossil remains of large Araucarias (*Aracarioxylon arizonica*). Living specimens of this species no longer exist any place on the earth. The fossil remains of *Callixylon Newberryi* are found in Indiana, Ohio, Pennsylvania, New York and parts of Canada. These species which once thrived in these regions are no longer extant upon the earth and would never have been known to us if their fossil remains had not been left to tell the story. The inability of these species to maintain themselves was obviously due to major changes in climate over long periods of time. From what we can learn about them from fossil remains, they thrived in a much warmer and more moist climate than exists in the locations where their fossil remains are now. They would not be able to continue their existence today even if they were again placed in the same geographical location.

Fig. 1. A graceful branch of *Ginkgo biloba* displays its fan-shaped leaves.

While many species have disappeared from the living flora of the earth, some extremely interesting species, often known as "living fossils," are still represented in the present day flora. One such species is the Ginkgo tree (*Ginkgo biloba*) (Fig. 1). Although this species is frequently grown as an ornamental in the north temperate regions of the world, it is available today only because it was maintained in the monastery gardens of certain religious orders of China. Some Ginkgo trees which might be growing naturally have been found in central China. There is, however, considerable controversy as to whether this is a natural population or one that has been left behind by people who previously lived there. Fossil remains indicate that at one time either *G. biloba* or very closely related species of Ginkgo were present in both North America and Europe as well as China. At present, planted specimens of Ginkgo are to be found in all of these geographic locations. One very large

Fig. 2. Part of the Metasequoia collection at the Morris Arboretum.

specimen is growing on the campus of McGill University in Montreal, Canada. This indieates that it is able to withstand reasonably severe winters. There are almost no insect or fungus enemies of Ginkgo. Why then, has it disappeared from our natural flora? As yet the complete answer is not clear.

If this paper had been written thirty years ago, Dawn Redwood (*Metasequoia glyptostroboides*) (Fig. 2.), if included at all, would have been listed as a species known only through fossil specimens. In 1945, living speeimens were discoverd by Mr. T. Wang in central China (Hu 1948). This is another species which falls into that unique category of a "living fossil." It was growing in a very limited arca. The total number of mature specimens reported by Mr. Wang was 25. Later field studies in 1947 by Mr. H. Hseuh brought the census of large Metasequoias up to 100. Dr. E. D. Merrill (1948) said, "It is suspected that the ehanees of this species persisting much longer in this last stand is not very promising." Geological information indieates that the distribution of both Metasequoia and Ginkgo was reduced by glaciation, but there must have been other influences which limited their post-glacial spread.

When Dr. Luey Braun (1950) made her famous ecologieal studies of eastern United States hardwoods, there were enough Ameriean ehestnut (*Castanea dentata*) trees in parts of the southern range of the area she studied to justify her use "Oak-Chestnut" as one of the ecologieally descriptive terms for the vegetation of the area. However, about 1904 ehestnut blight, caused by the fungus (*Endothia parasitica*) was introduced into the United States and so many ehestnut trees have died that now one rarely sees a specimen of *C. dentata.* Perhaps resistant strains will be developed, but so far there is little evidence that naturally occurring resistant strains have evolved. Plant pathogens introduced into a totally new environment may be a very potent influence in helping to eliminate native speeies.

One of the most dramatic examples of a plant species disappearing from the natural population of the United States is the famous Franklinia tree (*Franklinia alatamaha*). Although this small tree is cultivated in some gardens of eastern Unitcd States, it has completely disappeared as a part of the native flora. The Franklinia tree was discovered by John and William Bartram in 1765 (Harper 1958). In their famous Bartram "*Travels*," they reported having found it ncar Fort Barrington, Georgia. At that time, they collected specimens and took them back to the Bartram Botanical Garden in Philadelphia. This plant species was last reported in the Fort Barrington region in 1803. Since that time no one has found it growing wild in nature. If it had not been so well illustrated by William Bartram and he had not brought back specimens, one would hardly believe it ever grew.

Another species native to Georgia and which at present has a very limited range is *Elliottia racemosa.* This species whieh is a large shrub or small tree is presently reported from only eight stations, each of limited extent, in Georgia. Some have suggested that its limited distribution may be due to the pressure of agrieulture in the arca, but this seems questionable since so many other species associatcd with it have managed to retain a very much more general distribution. J. K. Small (1933) suggested that *E. racemosa* is self-sterile, consequently isolated specimens spread only by root suekers; hence, its limited distribution. This seems doubtful sinee investigations by the author showed abundant formation of seed with well devcloped embryos in them. Moreover, these seeds are light and well adapted to wind distribution. Why is *E. racemosa* so limited in distribution and population? There is mueh evidenec that we need to know more about *the unique requirements* of this species.

In spite of the fact that there are very many speeies of Orchidaceae in mueh of the north temperate zone, species of this family are becoming rare to very rare in the United States. There are several ex-

planations of their reduced population. In nature, orchids reproduce by seed. Although a single plant may produce many hundreds of thousands of seed in a single season, these seeds are extremely small. A mass of them appears as fine dust. Individual seeds cannot be clearly seen without some magnification. A seed of this size has almost no stored food to help the very young plant along in its early stages of growth. In addition to other difficulties, orchid seed require the association of a fungus for germination under natural conditions. When one considers all these complications, it is clear that any one seed stands a slim chance of growing into a new plant.

The habitat of most orchids is also very exacting. For many species, the habitat is acid bogs which are high in organic matter. Drainage followed by grazing or cultivation has eliminated orchids as part of the flora of these once favorable areas. Although they would be able to maintain themselves in their proper habitat, these habitats are rapidly disappearing and with them the orchids. Since orchids reproduce only very slowly, they are likewise very adversely affected by picking the flowers.

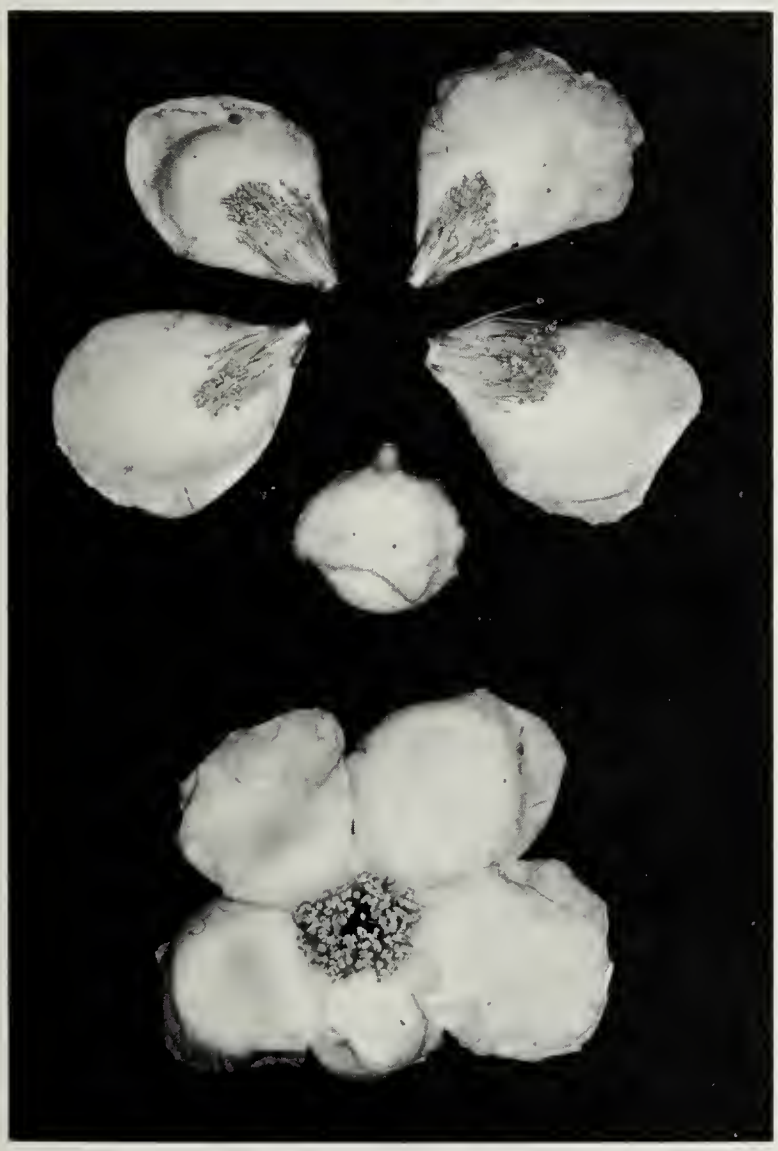

Fig. 3. The summer-blooming *Franklinia alatamaha* is prized by gardeners.

Fig. 4. Here is a young specimen of *Elliottia racemosa* in rich bloom at the Arboretum.

Thus we see that the disappearance of plant species is not due to one cause, but to many and varied causes. Some of these causes we know very well, others are more obscure. Some are completely beyond our control; they deal with phenomona over which man as yet, or in the forseeable future, has no control. Others we are unable to control because we do not understand their nature.

Some plant species are very exacting in their habitat requirements while others are very much more tolerant in the ecological conditions under which they will thrive. Observation makes clear that there is no single ecological condition favorable to all species. This emphasizes the fact that if a species is to continue as a part of the native flora, the most significant factor is to retain the habitat favorable for its existence.

Plant species have disappeared and doubtless will continue to disappear from our native flora. If man is to extend a favorable control over this phenomenon, it will be necessary to utilize his present knowledge and to study individual species in order to extend his knowledge into the complex problem of why plant species become extinct.

Readers will be interested to know that others share Dr. Guard's opinion that the problems unique to each threatened species must be studied. Recently a Rare Plant Study Center was established at the University of Texas, Austin, Texas. There are about 100 species of plants native to the United States that are endangered. In addition to studying these plants, the center is promoting their propagation and distribution, especially to arboreta and botanic gardens.

On request, the center will send lists of names and regional distributions of rare and endangered plants, as well as of other plants considered unusual enough for concern. Persons and organizations who might help further the goals (for example, in seed collection), or who require help in similar efforts have been encouraged to contact the center. Dr. Marshall C. Johnston is Director.

For additional reading in the interesting stories of Ginkgo and Metasequoia, see the two articles by Dr. Hui-Lin Li in the Morris Arboretum Bulletin, vol. 7, p. 3-12; and vol. 8, p. 49-53.

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WEEDS OF LAWN AND GARDEN. John M. Fogg, Jr. 1945. $9.00. University of Pennsylvania Press. Philadelphia. 215 pp.

CHINESE FLOWER ARRANGEMENT. H. L. Li. 1959. $6.95. Van Nostrand. Princeton. 125 pp.

THE GARDEN FLOWERS OF CHINA. H. L. Li. 1959. Chronica Botanica 19. The Ronald Press. New York. 204 pp.

ORIGIN AND CULTIVATION OF SHADE AND ORNAMENTAL TREES. Hui-Lin Li. 1963. $9.00. University of Pennsylvania Press. Philadelphia. 282 pp.

ALKALOID-BEARING PLANTS AND THEIR CONTAINED ALKALOIDS. 1957-1968. J. J. Willaman and Hui-Lin Li. 1970. $6.00. The Lloyd Library and Museum and the American Society of Pharmacognosy. Cincinnati. 286 pp.

TRICHOMES OF SOME ECUADORIAN BROMELIACEAE

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Fig. 1. *Aechmea angustifolia* Poeppig & Endlicher growing epiphytically near Manglaralto, coastal Ecuador.

The feeling of wonder with which Jameson(1865), Bates (1892), Spruce (1908) and others described Ecuador's flora and fauna is the astonishment that naturalists, myself included, feel toward the immense range in variation of organisms, plants and insects especially. Ecuador with 116,000 square miles, has been estimated to contain more plant species per unit area that any other portion of the Americas.(Steere, 1950), and speciation is the result of variation.

The plant family Bromeliaceae shows the same wide range in variation that is characteristic of tropical families plus a little extra besides. That little extra is the subject of this note. After three years of collecting, a great many bromeliads left Ecuador with me. Then, additional specimens were gathered together from earlier collections made by workers such as André, Jameson, Weberbauer, and Benoist that had been deposited in herbaria in England, France, Germany, and several United States institutions. These were studied, and keys and descriptions for 245 bromeliad species were prepared (Gilmartin, 1970).

Nearly a third of the species of this monocotyledonous family are epiphytes, growing attached to other plants such as trees (Fig. 1). They are not parasitic, since they do not invade the tissues of the individual to which they are attached; the problem of obtaining water must be solved by some mechanism that replaces the roots of conventional plants. It is now generally accepted that this is accomplished primarily by specialized water-absorbing trichomes on the epidermis, the 'trichompomps' of Mez (1904). These specialized hair- or scale-like structures, although not overly studied, are known to be widely variable in their structure and are particularly interesting for the clues that they provide to relationships within the family.

The importance of trichomes as transpiration-minimizers in addition to water-absorbers has been noted by Krauss (1948). In some species, the trichomes nearly cover the stomata, effectively cutting down transpiration.

The epiphytes with densely disposed trichomes are particularly successful in xeric (dry) habitats and in areas that characteristically have a distinct dry season;

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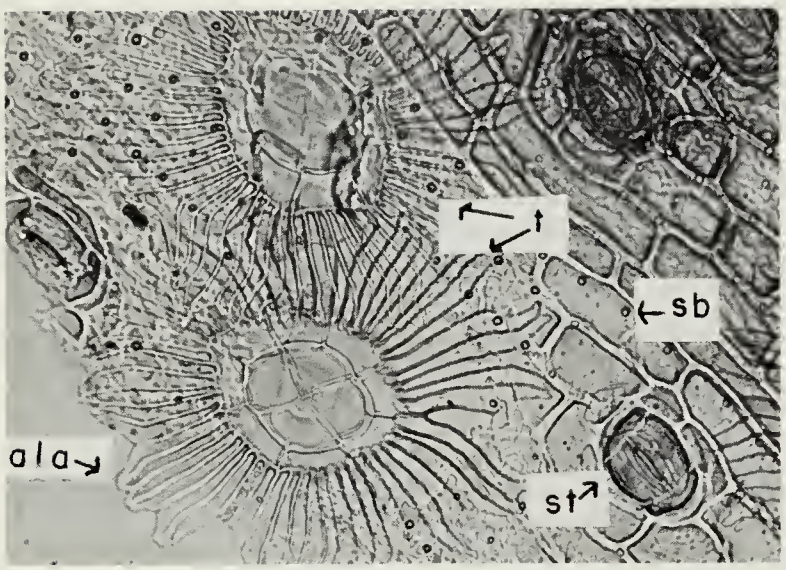

Fig. 2. *Guzmania hitchcockiana* L. B. Smith epidermis. ala, ala cells; t, trichome; sb, silica body; st, stoma. X 400.

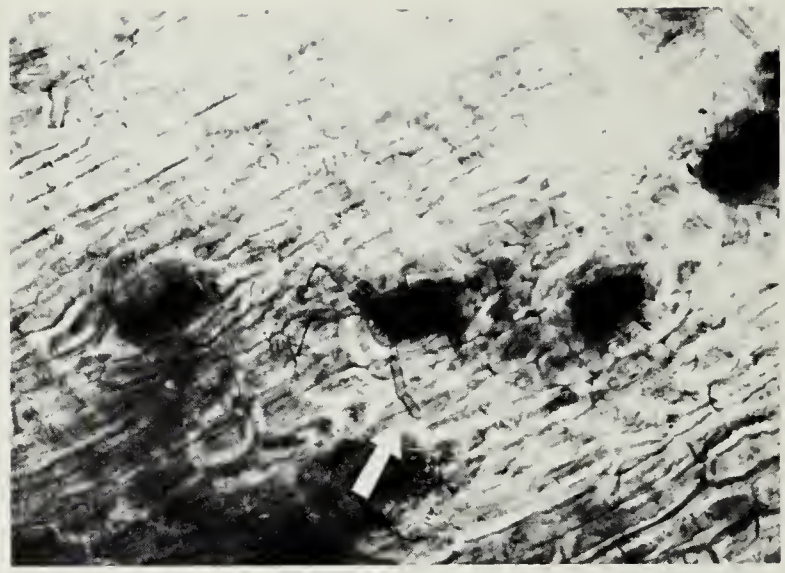

Fig. 4. *Pitcairnia pavonii* Mez trichomes and stomata X 500.

however, some species with numerous trichomes also grow in regions that are nearly continually moist but are in the vicinity of wind-swept mountain passes. The Ecuadorian Andes abound in these.

For a small area, Ecuador has a tremendous range in habitat types. (Steere, 1950, Allison, 1964, Gilmartin, 1970). With specimens collected from habitats with different environmental stresses, it is possible to illustrate not only the wide range in trichome types, but also to link the trichome types with the environmental conditions.

Photomicrographs showing some of the epidermal characteristics were made of leaf epidermal peels taken from the same relative position on mature leaf blades of different plants. The leaf fragments were softened in warm lactic acid for several days; then the peels were mounted in glycerine. Even though the subepidermal layers occasionally remained, the method produced slides that clearly show many of the important features of the surface view of trichomes, stomates, etc.

VARIATION IN TRICHOME TYPE

Members of the subfamily Tillandsioideae have symmetrical trichomes with conspicuous alae (wing-like portions). Those of *Guzmania hitchcockiana* Smith (Fig. 2), for example, consist of four central cells subtended by a stalk (not shown in these surface views) and eight outer cells surrounded by the elongate cells of the ala. Water between the ala and the underlying epidermis moves by capillary action and diffusion into the leaf mesophyll (Krauss, 1948).

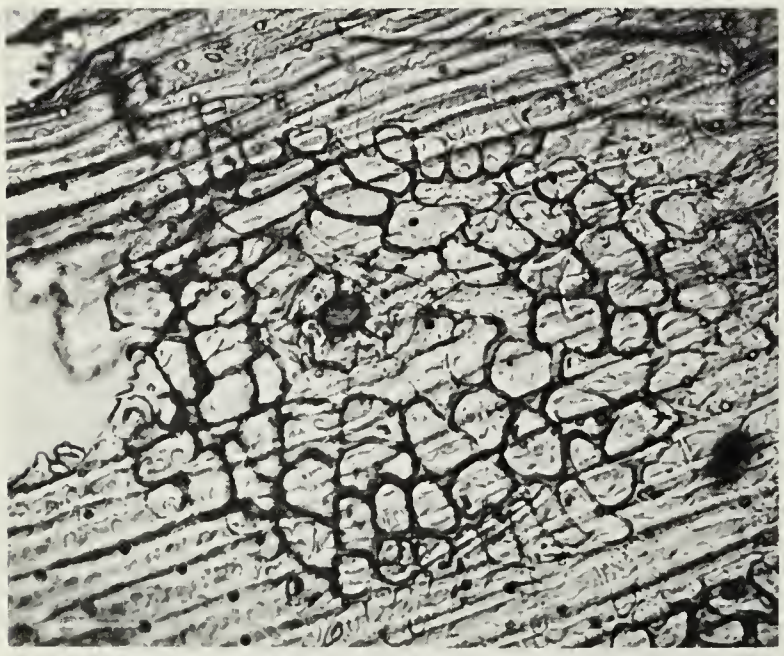

Fig. 3. *Aechmea angustifolia* trichome X 500.

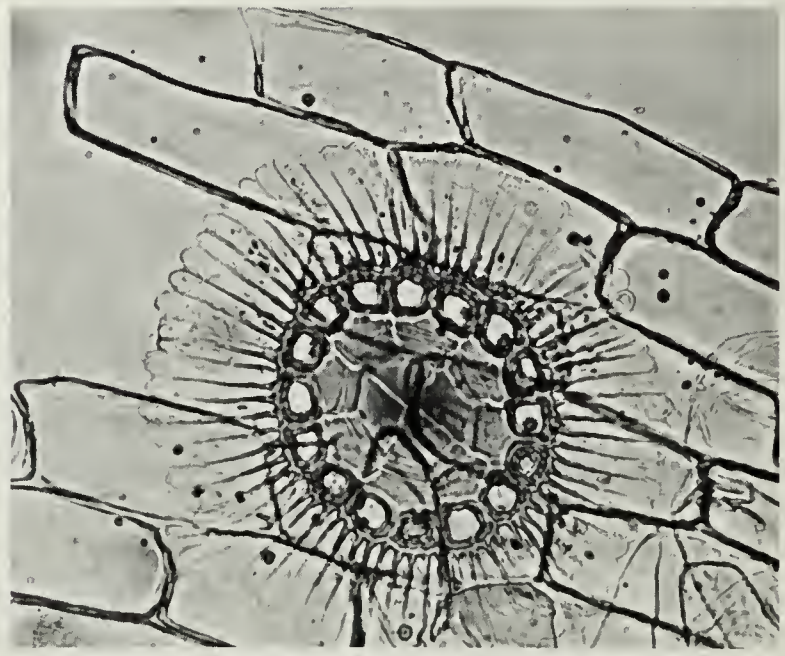

Fig. 5. *Tillandsia straminea* trichome X 500.

Several stomata are also visible in the same photomicrograph, as are many small silica bodies.

Plants of the subfamily Bromelioideae have less symmetrical trichomes (Fig. 3); the ala is less conspicuous; and the four central cells are not as sharply defined.

The subfamily Pitcairnioideae is represented in Ecuador by two genera, *Puya* and *Pitcairnia*, characterized by a filamentous type of trichome (Fig. 4). In the particular species illustrated, *Pitcairnia pavonii* Mez, the filamentous trichomes nearly cover the stomata.

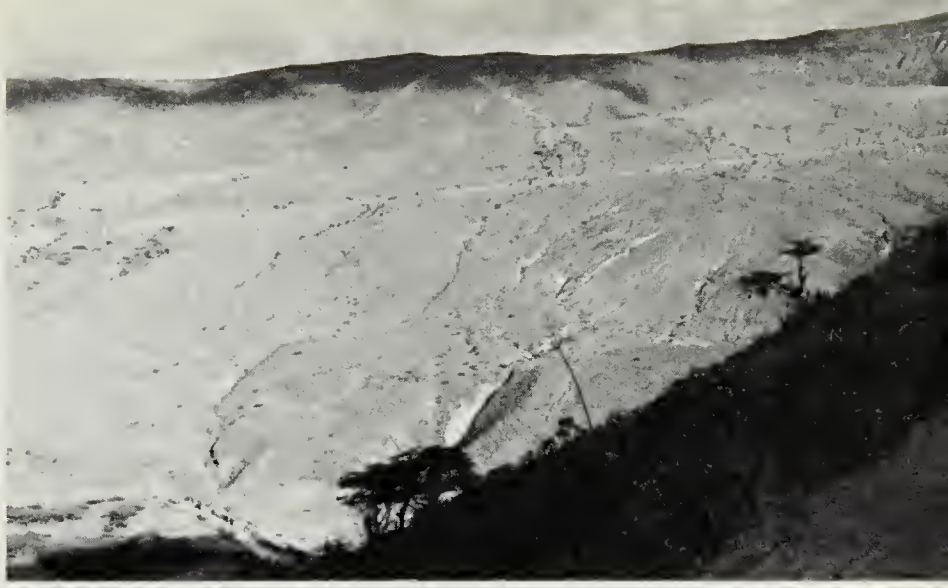

Fig. 6. Valley of the Río Oña, 101 km from Cuenca on the road to Loja, altitude 2000 meters.

HABITAT AND TRICHOME VARIATION

Tillandsia straminea H. B. K. (Fig. 5) was collected in the xeric area of the Andes which is shown in Fig. 6. This pretty bromeliad has especially elegant leaf trichomes (Fig. 5). Trichomes of the symmetrical shield type such as those of *T. straminea* often contain conspicuous amounts of tannins. The filamentous types do not and are totally distinct in form. The asymmetrical shield type is much less well defined in structure.

In contrast to the xeric regions, the moist Amazon slopes of the Andes facing the Amazon basin in eastern Ecuador such as along the Rio Pastaza (Fig. 7) support many species of *Guzmania*, for example, *G. conifera* (André) Mez, *G. bipartita* L. B. Smith, and *G. devansayana* Morren. Those from moist habitats do not have as many trichomes per unit area of epidermis nor are the cells of the ala as tightly fitted together as, for example those of the xerophytic *Tillandsia* shown in Fig. 5.

Another mesic habitat is in northwest Ecuador around Esmeraldas and Santo Domingo de los Colorados. Near the latter there are farms of "tagua" or ivory nut, *Phytelephas macrocarpa* Ruiz and Pavon. The bromeliad *G. hitchcockiana* L. B. Smith was collected there.

Near the coastal city of Guayaquil, several species of *Ceiba* (Bombacaceae) grow (Fig. 8), as well as bromeliad species such as *T. latifolia* Mayen. The latter is a xerophyte with trichomes so dense on the leaves that they form a covering which is velvety to the touch. The trichomes overlap and nearly cover the stomata; *T. tetrantha* (Fig. 9) is similar.

In the Andes, within and around the corn plots and potato fields of the Quechuan Indians, *G. variegata* L. B. Smith abounds. This species grows both epiphytically near the ground and terrestrially as well.

Fig. 7. Five km from Puyo, eastern Andean slopes, 600 meters.

Fig. 8. *Ceiba sp.* (Bombacaceae) on Santa Elena Peninsula, western Ecuador near sea level.

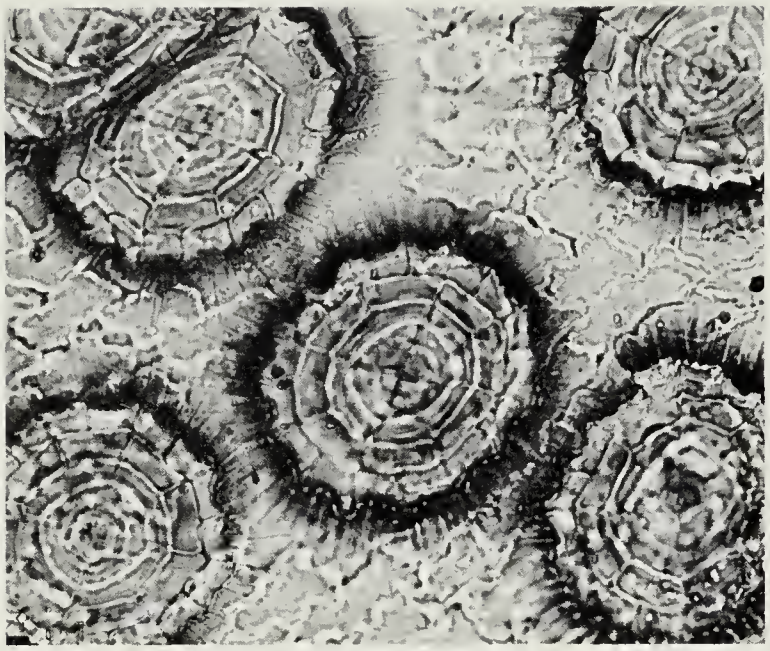

Fig. 9. *Tillandsia tetrantha* R. & P. trichomes X 500.

Fig. 10. *Puya parviflora* L. B. Smith stomata X 500.

Fig. 11. *Aechmea angustifolia* stomata X 500.

The habitat is moist and subject to only limited desiccation; the trichomes are moderately dense.

The Galápagos Islands, some 600 miles west of mainland Ecuador, also have a variety of habitat types. An endemic bromeliad species, *T. insularis* Mez (Fig. 12) grows in the transition zone between the xerophytic and mesophytic communities and within the *Scalesia* (Compositae) forests of the latter. Fig. 13 shows three burros laden with sacks of bromeliads.

STOMATA AND TRICHOMES AS SYSTEMATIC TOOLS

The dispersal and configuration of the stomata also vary. The Tillandsioideae species have their stomata more or less scattered. Stomata of the Pitcairnioideae species, however, occur densely clustered in rows (Fig. 10).

The shape of the stomata was found to be relatively consistent within certain taxa and strikingly different from group to group. For example, each of the several species and genera of the subfamily Bromelioideae which were examined had round stomata similar to those in Fig. 11, while all of the Pitcairnioideae species that were examined had stomata that were decidedly elliptical in shape (Fig. 10); however, Robinson (1969), who critically examined three other genera of this subfamily observed and documented a much greater variation in stomatal shape than was observed in the species of *Puya* and *Pitcairnia.*

Variation between and within species is the axis around which any systematic study turns. Estimates of the parameter, variation, help us to establish limits for circumscription of taxa such as species, genera, and families. The recognition of patterns of variation can be intuitive and it can be, at least partly, quantified (Gilmartin, 1969a, b, for example). Whatever approach we use and whichever kinds of data—gross morphological, anatomical, or molecular, it is work that is enjoyable and scientifically useful.

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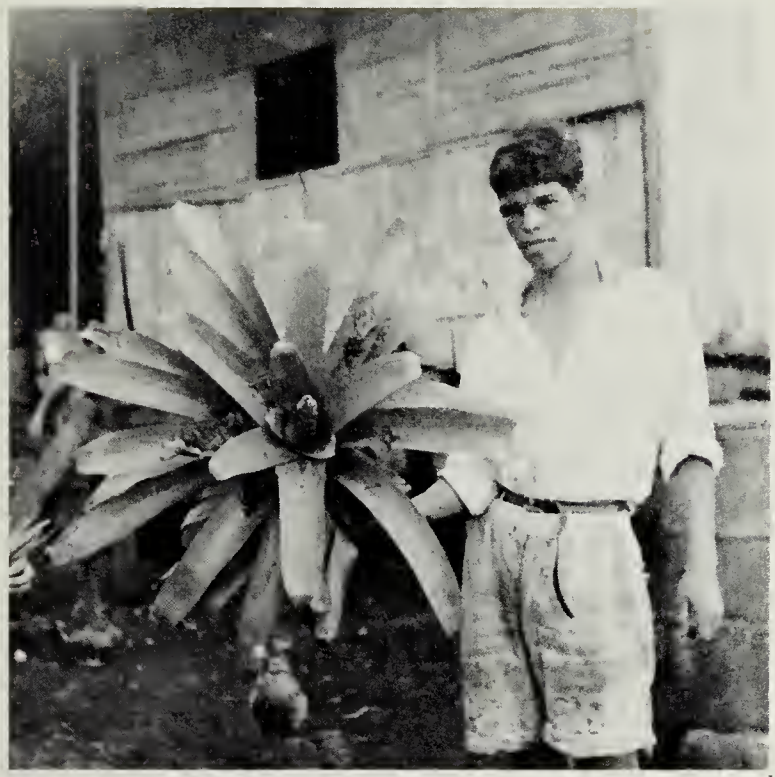

Fig. 12. A Galápagos Islands school teacher's son and *Tillandsia insularis,* endemic bromeliad. El Occident, Galápagos Islands.

Fig. 13. Burros carrying bromeliad collections to the port on the western side of Isla Santa Cruz (Indefatigable), Galápagos.

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Rare Fruit on the Hybrid Holly 'John T. Morris'

A. ORVILLE DAHL

This spring, the Morris Arboretum specimen of hybrid holly 'John T. Morris' is producing, for the first time in our observation, a cluster of fruit. It is, of course, not unusual for pistillate (female) plants of holly to produce berries, but 'John T. Morris' is a staminate (male) cultivar. It was selected from a cross between two Chinese species, *Ilex cornuta* Lindl. and *I. pernyi* Franch. The related cultivar 'Lydia T. Morris' is a pistillate selection from the same hybrid population (see 1). For profuse production of the ornamental bright red fruits (berry-like drupes) it is ordinarily necessary to include both cultivars, or a staminate individual of a related species of the same section of the genus in one's garden.

In Hu's (2) intensive taxonomic investigation of over one hundred species of *Ilex* occurring in China, *I. cornuta* from eastern China is placed in the *Aquifolioides* series of section *Aquifolium* of the genus. She regards *I. cornuta burfordii* (S. R. Howell) De France, which is reported as one of the parents of the Morris cultivars, as a clone based on vegetative propagation of an entire-leaved shoot of *I. cornuta.* The original example of the Burford cultivar occurred in West View Cemetery, Atlanta, Georgia.

Hu places the other parental species of the Morris hybrid, *I. pernyi* of central and western China, in the related series *Dipyrenae* of the *Aquifolium* section. Despite the assignment of *I. pernyi* to this series, its fruits typically enclose four stony seeds (pyrenes) as is the case with *I. cornuta.*

In summarizing sexual dimorphism in the Chinese species of *Ilex,* Hu reports them to be dioecious, that is with functionally unisexual flowers—either staminate or pistillate—borne by separate plants; however, in more generalized treatments (3) of *Ilex* and the family to which it belongs, the *Aquifoliaceae,* the range of dimorphism includes in addition to the dioecious condition the occasional polygamous state in which both unisexual and bisexual flowers occur on the same plant.

It is this occasional, and currently rare, polygamous behavior of our specimen of *Ilex* 'John T. Morris' which has suggested this brief sketch.

The fruits are globose, about 10 mm. long and 9 mm. in diameter. Those of *Ilex* 'Lydia T. Morris' are similar, being 9 mm. long and 8 mm. in diameter. Both varieties are four-seeded with the presumably fertilized ovules still relatively small which is also the current level of development in *I. cornuta* at this writing. The ripe, globose fruits of *I. cornuta* are 8-10 mm. in diameter while those of *I. pernyi* are usually 7-8 mm. in diameter.

Hu has discussed at some length the sexual dimorphism of inflorescences in the Chinese hollies. In general, the male inflorescences are more prolific than the female flower clusters. There appear to be significant differences in the length of the individual flower stalks (pedicels). For example, in *I. cornuta* the pedicels of the staminate (male) flowers are 5-6 mm. long while those of the pistillate flowers are 8 to 20 mm. in length. In *I. pernyi* the pedicels of the male flowers are 1 mm. in length while those of the female flowers are 2 mm. long. Thus in both parental species the pedicels of the female flowers are significantly longer than those of the male flowers.

In the case of the Morris hybrid hollies, it is of interest to note that the pedicels of the fruits of 'John T. Morris' are distinctly longer (8mm.) than those of 'Lydia T. Morris' (3mm.). Thus it would seem that in this character the staminate selection is closer to *I. cornuta* than to *I. pernyi.*

Small, potted plants of both of the Morris hybrid hollies were distributed to Associates of the Morris Arboretum during May of 1970 (1). According to some reports these have grown well. It would be of interest to make observations in the future on the unusual fruiting behavior of *Ilex* 'John T. Morris'.

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ARBORETUM BENEFIT CONCERT

A gift of love was received on April 23 when mezzo soprano Victoria Villamil, right, clarinetist Joseph Coleman, and pianist Doris Coleman presented their concert for the benefit of the Morris Arboretum.

The Woodmere Art Gallery, close to the Arboretum, was the scene of the concert and was charmingly filled with marvelous blends of voice, instruments, paintings, and sculpture.

We thank the artists and the gallery for their generosity. The response of the community to this first benefit event was gratifying, and it is with pleasure that we reprint the following review from the Chestnut Hill Local.

A MUSICAL SOIREE AT THE WOODMERE by Ellen V. P. Wells (in the *Chestnut Hill Local*)

One could do a lot worse than ending a Sunday in April with a concert in the handsome surroundings of the Woodmere Art Gallery. When artists of the calibre of Victoria Villamil, mezzo soprano, Joseph Coleman, clarinetist and Doris Coleman, pianist, perform, it is a rare spring day indeed.

The program given as a benefit for the Morris Arboretum, was an easily assimilated range from Purcell to Satie with a large dollop of whipped cream for dessert in the form of three Shubert lieder, sung by the comely and charming Miss Villamil.

In the hands of Joseph Coleman, the clarinet achieved a birch-like flexibility, most exquisitely culminating in the virtuoso final section of the Concerto Rondo in B Flat Major by Mozart - a theme and variations piece on a melody by Bellison. Mr. Coleman, a member of the faculty of the Bryn Mawr Conservatory, exploited the full range of emotion of which the instrument is capable. The audience loved it. His other major offering, the Brahms Sonata No. 1 in F. Minor, a favorite clarinet show piece, was equally enjoyed.

Miss Villamil, elegant and poised in an aqua and silver dress, showed her operatic range in the three part Venetian Regatta by Rossini, to the graceful accompaniment of the barcarolle rhythms of the piano. The mood was clearly Venetian, carefree and more concerned with love than affairs of state. It was an all too brief vacation. Miss Villamil's voice seemed especially suited to the frothy inconsequentials of five songs by Satie: themes of love and fashion and pretty girls that have long gone out of style with contemporary composers but are fun to hear again, stylistically comparable to a Fragonard or a Watteau.

The two artists, always sustained and complimented by the empathetic artistry of the pianist, came together for a memorable finale in Shubert's yearning song, The Shepherd on the Rock. Miss Villamil's voice and the poignant repetitions of the clarinet were like spring lightning flashes chasing each other across the sky. Their encore, a lullaby, ended a very pleasant evening.

ASSOCIATES' NEWS

NEW DIRECTOR

Dr. H. L. Li, Taxonomist and Professor of Botany, who, since January 1, 1971, was Acting Director, has been appointed Director of the Arboretum. Not long ago he was elected to the Council of the Society for Economic Botany, and recently has received a National Science Foundation grant of $41,000 for a two year cooperative project with botanists in Taiwan for completion of "The Flora of Taiwan."

BRONZE AWARD

We are pleased to announce that the September and December, 1971 issues of *The Morris Arboretum Bulletin*, entered in the Delaware Valley Graphics Society's competition, "Neographics '72," won a bronze award.

ANNUAL BARNES LECTURE

Professor Ian McHarg gave the tenth annual Laura L. Barnes Lecture on April 27. The audience, listening to "The Garden as a Metaphysical Symbol," filled the large gallery at the Woodmere Art Gallery.

RESEARCH FELLOW

Dr. Ju-Ying Hsiao, former Morris Arboretum Fellow, has become Research Fellow at the Arboretum and will work on the Flora of Taiwan Project.

GARDEN CLUB OF AMERICA ZONE MEETING

On May 11th the Arboretum was host to the Zone V meeting of the Garden Club of America for the second time, the first being in 1961. Besides the regular Zone members, many of the Garden Club of America officers and Committee chairmen attended, even coming from as far away as Seattle, Washington.

Mrs. Rivinus welcomed them on behalf of the Board of Managers of the Morris Foundation and gave them an outline of the Arboretum history and present activities. After the business meeting, the guests took a brief tour of the Arboretum including the medicinal garden which has been a recipient of the Founders Fund Award of the Garden Club of America. Mr. Abrams had it beautifully manicured and Mrs. Rivinus was proud of it. He deserved a lot of credit for, if you remember, it never stopped raining. The Arboretum was at its height of bloom and the view from the Gates porch was a particularly lovely sight. We have since received numerous enthusiastic letters of appreciation. (M.W.R.)

CONGRATULATIONS

One of your fellow Associates made the cover of TIME-LIFE. Ruth McVaugh Allen's enchanting color photograph of *Enkianthus campanulatus* appears on the cover of the recently published volume of the TIME-LIFE ENCYCLOPEDIA OF GARDENING entitled *Flowering Shrubs.* Several more are inside.

PLANT DISTRIBUTION DAYS

Several hundred plants from a varied assortment of trees and shrubs were distributed to Associates on May 19 and 20. Persons who are interested in obtaining particular species in future years may let their wishes be known at the Arboretum office. The new phone number is Chestnut Hill 7-5777. If enough preferences are expressed, special efforts will be made to provide the plants.

GATE HOUSE NEARS COMPLETION

The Gate House on Hillcrest Avenue is nearing completion. It had been hoped that the new facility would be ready in early spring, but a strike of certain workers has greatly delayed finishing the work.

BOTANICAL SCHOOL PARTY

May Day began the last week of the spring session of the Botanical School, and was the occasion for the gathering of students and staff from the five classes for buffet dinner as guests of the Arboretum. Dr. Li was the featured speaker. His topic was "Some Historically Important Plants."

SPIN-OFF FROM SHORT COURSES

One of the advantages of the short course program to Associates of the Arboretum is that it enables the Associate to enjoy the facilities of the Arboretum more. Thus, a group of members who began as classmates in Dr. Schuyler's Plant Families course in the fall continued their studies unassisted during winter, taking "educated advantage" of the library and the herbarium.

SPECIAL WORKERS

During the month of May, the Arboretum was the sponsor of five area high school students in a volunteer work-study project. They were Sandra McClelland, Frances Rau, Steve Doyle, Scott Zeigler, and Peter Hughes. Many thanks to these fine students for a job well done.

Beginning in April, the Arboretum has been graced with the talents of Miss Isabel Wister. Isabel came to the Arboretum as a volunteer, but will be leaving this July to take a course in botany at Harvard. Our hopes are that she will return. Whatever her plans, we thank her for a tremendous job.

This summer we are fortunate in having two student employees, Michael Bonaventura and Richard Slaybaugh. Michael is a psychology major who will be entering graduate school this fall. Richard is a forestry major at The Ohio State University and will be returning there as a senior when the summer is over. (G.A.)

MORRIS ARBORETUM MONOGRAPHS

A SERIES OF SCHOLARLY WORKS ON BOTANY AND RELATED SUBJECTS

Unless out of print, books are available postpaid from the Morris Arboretum, if remittance accompanies orders.

THE BEGINNINGS OF PLANT HYBRIDIZATION. Conway Zirkle. 1935. 231 pp. University of Pennsylvania Press. (Out of print)

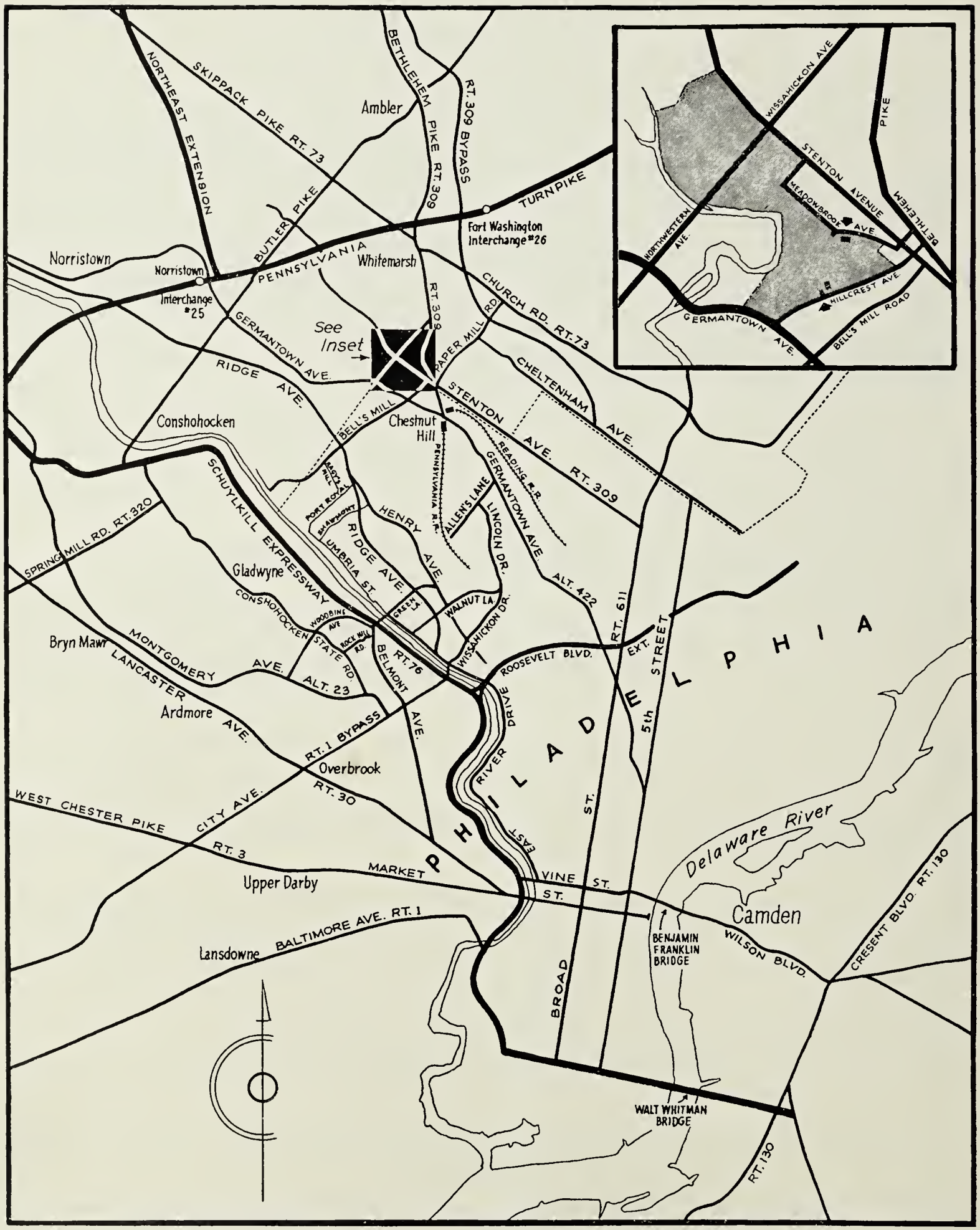
CONSERVATION OF RENEWABLE NATURAL RESOURCES. University of Pennsylvania Bicentennial Conference. Raphael Zon et al. 1941. 200 pp. $7.50. University of Pennsylvania Press. Reissued, 1969, by Kennikat Press, N. Y.

THE GENUS PHLOX. Edgar T. Wherry. 1955. 174 pp. $4.50. The Morris Arboretum.

WOODY FLORA OF TAIWAN. Hui-Lin Li. 1963. 974 pp. $18.75. Livingston Publishing Co., Wynnewood, Pa. and The Morris Arboretum.

A SELECTED GUIDE TO THE LITERATURE ON THE FLOWERING PLANTS OF MEXICO. Ida Kaplan Langman. 1964. 1015 pp. $22.50. University of Pennsylvania Press.

FLORISTIC RELATIONSHIPS BETWEEN EASTERN ASIA AND EASTERN NORTH AMERICA. Hui-Lin Li. 1952. Reprinted with a foreword bringing the literature review to 1971. 60 pp. $4.00. The Morris Arboretum.



MAP SHOWING ACCESS TO THE MORRIS ARBORETUM, PHILADELPHIA, PA.

MORRIS ARBORETUM

SEPTEMBER 1972 BULLETIN 23 (3)

The Morris Arboretum Bulletin is published quarterly at Philadelphia, Pa., by the Morris Arboretum, 9414 Meadowbrook Ave. Chestnut Hill, Philadelphia, Pa. 19118. Subscription $4.00 for four issues. Single copies $1.00. Free to Associates. Second-class postage paid at Philadelphia, Pa. Printed by the University of Pennsylvania Printing Office.

THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

TYPES OF MEMBERSHIP

Contributing	$10.00 a year	Supporting	$25.00 a year
Family	$15.00 a year	Sponsoring	$100.00 a year
	Donor $500.00		

TABLE OF CONTENTS

CREDITS: Cover by C. Y. Hsu Li, from *Trees of Pennsylvania* by H. L. Li; Fig. 1, author; Figs. 2, 3, 4, John M. Fogg, Jr.

COVER: *Cercis canadensis*, the Redbud, is native to Pennsylvania.

GROWTH AND DEVELOPMENT AT THE MORRIS ARBORETUM

ADVISORY BOARD OF MANAGERS

As our readers may have noted, the make-up of the Advisory Board of Managers shown inside the cover of each issue of the *Bulletin* has changed considerably. Furthermore, the University has kindly given the Advisory Board more freedom to act. In the past twelve months they have met seven times, rather than once, as was the custom before. By playing a more active role, the Advisory Board of Managers hopes to be of more service to the Arboretum, its members, the community, and the University. News of its activities will be announced through the *Bulletin* from time to time.

Let us acquaint you with the Board Members.

Dr. F. Otto Haas, the new Chairman of the Arboretum Board, is a native Philadelphian whose scientific training as research chemist, long experience in industry, and devoted participation in civic and community affairs uniquely qualify him to meet the multiple challenges of a university-affiliated arboretum. He is Chairman of the Board and a member of the Executive Committee of Rohm and Haas Company.

Dr. Haas is also Vice Chairman of the Board of The Haas Community Fund; a member of the Mayor's Committee of Twelve; Chairman of the Philadelphia Historical Commission; and a Director of the following companies: INA Corporation, Pennsylvania Manufacturers' Insurance Company, Philadelphia National Bank, and Standard Pressed Steel Company. He is also a member of the Executive and Finance Committees of the PMA Insurance Company and Standard Pressed Steel Company. In addition, he is Director of The Old Philadelphia Development Corporation and a member of the Philadelphia Society for the Preservation of Landmarks; the American Philosophical Society, American Chemical Society, member of the Board of Managers of the University of Pennsylvania Museum and of the Finance Committee of the International Union Against Cancer.

Marion W. Rivinus (Mrs. E. Florens Rivinus) is a true Philadelphian's "philadelphian," studying and enthusiastically supporting diverse activities of mankind, past and present. Her knowledge has been shared through the publication of nine books and many magazine articles. Extraordinary community and national activities related to horticulture, civic improvement, historic America, art, and environmental protection have brought her nine awards, including the Chestnut Hill Award for 1967. Mrs. Rivinus is a charter member of the Associates of the Morris Arboretum and was Chairman of the Advisory Council. She represents the Morris Arboretum on the Board of Directors of the Chestnut Hill Community Association.

Jane Jordan O'Neill (Mrs. Bertram Lippincott O'Neill) is another new member of the Board whose broad interests in civic affairs and horticulture keep her busy. She is a Trustee of the Academy of Natural Sciences, a member of the Board of Directors of the Planned Parenthood Association of Southeastern Pennsylvania, an Honorary Trustee of Chestnut Hill Academy, and has worked effectively for the Bishop's Fund and Clergy Daughter's Fund in the Episcopal Church, Diocese of Pennsylvania.

The most recent addition to the Advisory Board of Managers is Dr. William W. Marvel, President of the Philadelphia Academy of Natural Sciences. He is also a Trustee of the Wistar Institute. He has served on numerous other councils and boards, all of which have benefited from a deep interest in education that extends from his own community where he is a member of the Board of Education, to other parts of the world. He is, for example, a member of the Board of Trustees of Princeton-in-Asia, and has been a member of the Presidential Task Force on International Education.

William T. Hord, who became a member of the Board in 1970, serves as its Secretary. He is Vice President of the First Pennsylvania Bank as Officer-in-charge of the Trusts Division, and so is uniquely informed about matters related to the Morris Foundation. As a close neighbor to the Arboretum he is also in a unique position to evaluate both community and Arboretum needs. Mr. Hord participates in other important civic affairs as Chairman of the Board of Germantown Hospital, Accounting Warden of St. Paul's Church at Chestnut Hill, and Advanced Gifts Solicitor for the United Fund.

ANNUAL REPORT, ACADEMIC YEAR 1971-1972

The Morris Arboretum of the University of Pennsylvania was founded in 1933. As we approach its fortieth anniversary, it seems appropriate to reassess its achievements and to project its future course of development. The past year marked the beginning of a new chapter in the history of the Arboretum. Its increased recognition by the University administration as well as the constant, beneficial guidance of an active Advisory Board of Managers of the Morris Foundation under the chairmanship of Dr. F. Otto Haas were gratifying. These together have closely reviewed its past and produced new directions for development.

The Morris Arboretum, like most other institutions, is facing a rapidly evolving world. To respond to this changing scene calls for changes, not only in the performance of its avowed role, but even to insure or justify its continued existence. In the past year, the Arboretum has intensified its activities in several areas especially to meet the needs of an increasingly environmentally conscious public. Its staff has been called upon for a load of duties and the answering of requests from the public almost beyond its capacity. At the same time, it has begun to receive more notice and support from the public. We may look forward to an era of an expanded role including carrying out its functions as a university-affiliated arboretum designed by its founders to perform academic activities in teaching and research and to further the promotion of an understanding of botany and horticulture among the general public.

STAFF

Dr. H. L. Li, acting director since January 1, 1971, was named Director in March 1972. He is Professor of Botany in the Department of Biology and also acted as Curator of the Herbarium and as chairman of the Committee on the Arboretum. He is a member of the staff of the College of Allied Medical Professions of the University and a Research Fellow on the staff of the Department of Botany of the Academy of Natural Sciences of Philadelphia. He was elected a member of the Council of the Society of Economic Botany for 1972-75.

Dr. David R. Goddard, Plant Physiologist, underwent a change in title from University Professor of Science and Public Policy to University Professor of Biology and moved his office to Leidy Laboratories.

Dr. A. Orville Dahl, Botanist, returned in January 1972 from a year's academic leave which was spent on research at the Palynological Laboratory of the University of Stockholm. In April 1971, he also performed in research consultation for the Pollen Laboratories of the Danish Geological Survey in Copenhagen. He returned as Professor of Botany in the Department of Biology.

Dr. Patricia Allison, Plant Pathologist, is also Lecturer in Biology in the Department of Biology. She acted as Editor of the quarterly *Morris Arboretum Bulletin* during the past year, and assisted the Director in administering the Botanical School and in community relations. She was a member of the Committees on Library and the Arboretum within the Department of Biology.

Mr. Angus Heeps resigned as Superintendent in October 1971 and Mr. Gerald B. Abrams was appointed Superintendent in April 1972. During the interval, Mr. Robert Pennewell, Gardening Foreman, was in charge of maintenance. Mr. Abrams holds a B.S. degree in Horticulture and a M.S. degree in Plant Science from the University of Delaware and before coming to us was Superintendent of the Horticultural Park and Arboretum of the Department of Horticulture at Purdue University.

BEQUESTS AND GIFTS

The Arboretum received a bequest of $5,000 from the Trust of the late Otto T. Mallery in September 1971 to be used for the renovation of the fountain in the rose garden and other architectural embellishments for improvement of the rose garden.

The $15,000 Joseph R. Jarvis bequest was converted in September 1971 into the J. R. Jarvis Arboretum Fund at the First Pennsylvania Bank to be used for educational and research purposes.

Mrs. E. Florens Rivinus made a gift of $500 toward the initiation of a gift shop in our new gate house.

GROUNDS AND COLLECTIONS

Although we were continuously hampered by the shortage of grounds staff, the maintenance of the grounds has been carried on and improved in efficiency. The rose garden restoration was continued, as was that of the wall garden. The medicinal plant garden was completely renovated. In May and June, our work was helped by a number of young volunteer workers.

The winter was comparatively mild and snow damage was relatively slight. An unusually heavy rainstorm in early November, however, destroyed or severely injured twelve big trees, especially along the lower meadow. The damage was due to the fact that the trees were in exceedingly dense foliage as a result of the relatively moist summer and some loaded, in addition, with a full crop of fruits. The most serious loss was the breaking up of half of the once beautifully symmetrical Ohio Buckeye, *Aesculus glabra*, near Gates Hall which disfigured it completely. This storm was followed by a severe windstorm in February which uprooted an additional number of trees, among which was the rare *Pinus griffithii zebrina.*

Mr. Abrams, upon assuming his duties in April, made plans to schedule the maintenance of the grounds in conjunction with general and gradual restoration of special areas and collections. A revision of the control calender was made with the advice of the Pathologist, Dr. Allison. Dr. Allison supervised the evaluation of a new fungicide in the rose garden.

The boundary matter, mentioned in our last report, is now being negotiated by the Morris Trust at the First Pennsylvania Bank.

Mention must be made again of vandalism, which increased in extent over the last year. In order to protect the collections and buildings adequately, a larger security force is a need of great priority.

BUILDINGS

The construction of the new Gate House at the Hillcrest Avenue entrance was originally scheduled to start in October 1971 but was held up by the City government for a hearing on the waiving of the requirement that the house be set back 25 feet from the property line. Its actual construction began in January and work progressed satisfactorily, until, near completion in March, it was delayed by the strike of cement truck drivers. It seems that we must await its completion sometime after the summer.

The completion of the Gate House will help in disseminating information about the Arboretum more effectively and, hopefully, in controlling to a certain extent the excessive vandalism. Room for a gift shop is provided within the Gate House and preparatory work for its operation is now underway.

Restoration of the rose garden fountain and the long-damaged balustrades was scheduled to begin in May with the help of the Mallery bequest but was also temporarily held up by the cement truck driver's strike.

PUBLIC AND EDUCATIONAL SERVICE

The Arboretum Staff was called upon to answer numerous questions, by telephone, by mail and in person, on botanical, horticultural and library problems by Associates and the general public. Questions frequently took the form of plant identification and diagnoses and advice on plant injury, pests and disease. We were also called upon to speak to garden clubs and other institutions.

The library was consulted frequently by the public as well as by students from the University. Space for expansion and manpower for curating the collection are *dire needs.* The herbarium was consulted by scholars and visited by classes from schools. The grounds, besides being open to the general public, were much used in this way, and were visited and toured by 23 school and garden groups. Among these, meeting at the Arboretum May 11, 1972, was Zone 5 of the Garden Club of America which originally sponsored the establishment of the Drug Plant Garden. Three tours were conducted for our Associates on Saturday mornings in the fall of 1971.

The Botanical School, which offered a series of non-technical courses in botany and practical horticulture designed for Associates and the public, presented a spring and a fall session, each consisting of six weeks. Four courses were offered in the fall as follows: Fundamentals of Ecology by Dr. Li, Important Plant Families by Dr. A. E. Schuyler, Gardening Practices by Mr. William Breintnall, and Field Studies of the Fungi by Dr. Allison. There were 66 enrollees. Five courses were offered in the spring as follows: Organization and Function of Plants by Dr. Dahl, Conifers by Dr. Li, Plant Propagation by Mr. Breintnall, Molds, Mushrooms and the Environment by Dr. Allison, and Classification and Identification of Plants by Dr. Schuyler. There were 58 enrollees. In addition, Dr. Allison supervised one Tutorial Botany student. Each session was concluded by a meeting with a special lecture and a social gathering.

The Arboretum cooperated with the Pennsylvania Horticultural Society in sponsoring the Summer Garden Workshop for children, conducted on the Farm area. The 1971 summer session, meeting in July and August had 30 plots for individual gardens. The workshop was extended into the fall and winter during which 12 weekly indoor meetings were held in Gates Hall.

Dr. Allison participated in the Parkway High School Program at the Pennsylvania Horticultural Society and in the Cheltenham Township Adult School.

The 10th Barnes Lecture was given by Professor Ian McHarg, Chairman of the Department of Landscape Architecture and Regional Planning at the University. His topic was "The Garden as a Metaphysical Symbol." It was held at the Woodmere Art Gallery in Chestnut Hill on April 27, 1972.

The Woodmere Art Gallery also graciously provided their facilities for a benefit recital for the Arboretum held on April 23, 1972. The artists, who generously contributed their time and talents, were Miss Victoria Villamil, mezzo soprano, Mr. Joseph Coleman, clarinetist, and Mrs. Doris Coleman, pianist. Both of these events were well attended and reported in the local press.

The Arboretum was represented for the first time on the Board of Directors of the Chestnut Hill Community Association by Mrs. Rivinus, a member of our Advisory Board of Managers, who was elected to this post by general balloting. Our activities were reported regularly in the community paper, the *Chestnut Hill Local.*

Plant distribution to Associates was held on May 19 and 20, 1972. Associates were offered a choice of two plants from a group of several different kinds of trees and shrubs. Our seed exchange list for 1971 with other arboretums and botanical gardens carried 50 items.

The University Recreation Area was used by 18 University community groups from late spring to early fall. The administrative building, Gates Hall, was used for gatherings other than our own activities, by 9 groups both within and without the University.

During the year, 124 new members joined as Associates of the Arboretum. A program for a membership drive has been under consideration with the help of the University's Development Office, and already has included the preparation of a new brochure. The Development Office has also been helpful in our formulation of an event to mark the 40th anniversary of the Arboretum in 1973.

DEPARTMENTAL INSTRUCTION AND ACTIVITIES

Members of the academic staff participated in the formal instruction of the Department of Biology. Courses presented included Biology 320, Plants and Human Culture by Dr. Li in the fall; Biology 200, Systematic Studies of the Flowering Plants by Dr. Dahl; and Biology 410, Biology of the Fungi by Dr. Allison in the spring. Mr. J. Y. Hsiao, Morris Arboretum Fellow, assisted in the laboratory work for Dr. Li's and Dr. Dahl's courses. All of these courses utilized the Arboretum's grounds and collections in their work. Dr. Li also supervised Biology 999, a research course for one student in both fall and spring. Dr. Allison supervised Independent Study by one student, beginning June 1972.

RESEARCH

Dr. Li carried on a research project entitled "Chemosystematic Studies on the American Oaks" supported by a 2-year grant ($6,350), June 1971-May 1973, from the Michaux Fund of the American Philosophical Society. In June 1972, he received a 2-year grant from the National Science Foundation ($41,000) for a study of "The Flora of Taiwan." The latter is a cooperative project with Taiwan botanists. He is assisted by Mr. Hsiao in these researches. He completed the preparation of a manual on Pennsylvania trees which will be published by the University of Pennsylvania Press.

Dr. Dahl continued in his association with Dr. Allan H. Brown of the Department of Biology with the NASA Biosatellite research project on plant growth under weightless environment at the University Science Center.

Dr. Allison has made progress in studies of *Pseudocoprinus venustus* in the following areas: longevity of basidiospores; interrelationships of number of basidiocarps, weight of basidiocarps, and production of basidiospores; influence of carbohydrate-nitrogen source ratio on reproduction.

Mr. Hsiao, as Morris Arboretum Fellow, completed his thesis research under the supervision of Dr. Li which was entitled "Biochemical systematic and numerical taxonomic studies on the genus *Platanus.*"

PUBLICATIONS

Four issues of the quarterly *Morris Arboretum Bulletin* were published under the editorship of Dr. Allison. Improvements made in the format received favorable comments. She was the recipient, for two issues in Fall and Winter 1971, of a bronze award in "Neographies '72," a competition sponsored by the Graphic Arts Association of Delaware Valley.

Guide to the
WOODLAND VEGETATION
on the
UPPER WISSAHICKON CREEK FLOOD PLAIN

PHILIP R. PEARSON, JR.[a]

INTRODUCTION

With the rapid expansion of the Philadelphia suburbs during the 1960's, it soon became apparent that the remaining woodlands on the upper flood-plain of Wissahickon Creek and its tributary Sandy Run were in danger of being destroyed. This survey was carried out with two ideas in mind: 1) to provide a quantitative description of the existing vegetation before its destruction and 2) to provide data that, should the woodlands escape destruction, could be used by future investigators as a basis for comparisons.

LOCATION AND GENERAL CHARACTERISTICS

In this suburban Montgomery County area, totally undisturbed stands do not exist but it was possible to select woodlands that had not been disturbed in recent years which varied in size from 3 to 10 acres. These were the only stands remaining on the upper Wissahickon of the size and quality for study. The woodlands border the upper reaches of the creek where its gradient is gentle before reaching the "gulph" near the Philadelphia city line where the stream drops through Fairmount Park to join the Schuylkill River. All the stands in figure 1 are located on areas mapped as being flooded at least once every 50 years (U.S. Army, 1965).

The bedrock under stands 3, 4, 6, and 7 is the Triassic Stockton Formation composed of gray sandstone, arkose, and red shale. Another Triassic formation, the Lockatong, underlies stands 1 and 2 with its dark, hard shale and fine-grained sandstones. The remaining stand, 5, is underlain by the Cambro-Ordivician Shenandoah Limestone (Smith, 1908). The two alluvial soils are the Rowland and Bowmansville silty clay loams. Stands 2 and 4 occur on the better drained Rowland while the others occur on the less

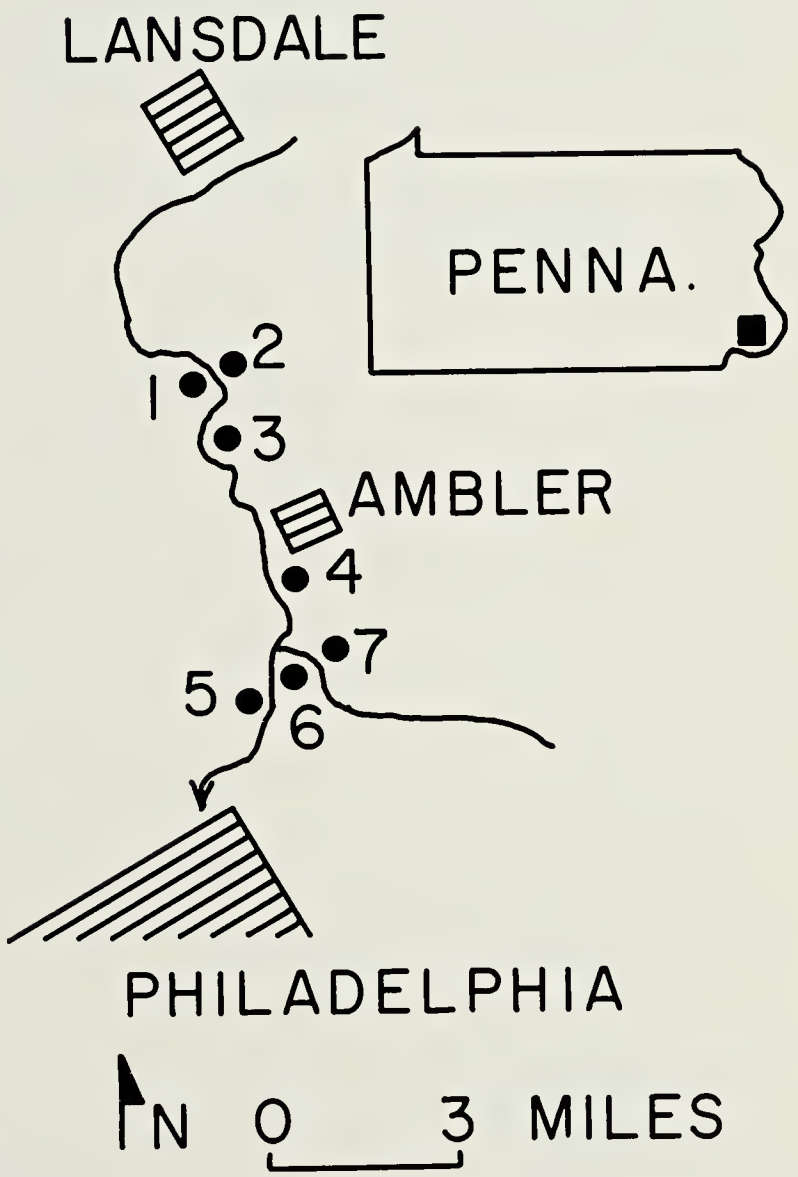


Fig. 1. The upper flood-plain of Wissahickon Creek extends from the vicinity of Lansdale to the Philadelphia city line. Sandy Run, a major tributary, flows between stands 6 and 7 to enter the Wissahickon.

[a] Professor, Biology Department, Rhode Island College, Providence, R. I. Field work financed by a summer research grant from Temple University, Philadelphia, Pa.

well drained Bowmansville (Personal communication, R. Thompson, U.S. Soil Conservation service).

There are between 170 and 180 days free from killing frosts the last of which occurs about 20 April and the first about 20 October. Annual precipitation is between 44 and 46 inches with 22 to 24 inches of this total coming between April and September inclusive (Reichelderfer *et al.*, 1941).

METHODS

First, the plants were identified and named according to Gleason (1952). Then, in order to assess dominance, estimates were made of their size (diameter at breast height, height), basal area, and frequency of occurrence. Data were gathered from 25 stations in 6 of the 7 stands. Stand 6, while of excellent quality, was large enough for only 15 stations. At each station, the Bitterlich Variable Radius method, as described by Grosenbough (1952), was used to estimate the basal area of trees. The trees tallied were grouped into size classes of 1-3.9, 4-11.9, 12-23.9, and 24 inches and over, dbh (diameter at breast height). A circular plot covering 25 square feet yielded data for herb and shrub frequency and for frequency and density of seedlings and saplings. Tree specimens up to 18 inches tall were considered seedlings, while stems taller than 18 inches and up to 0.9 inches dbh were recorded as saplings. Shrub heights were measured with a 6 foot ranging pole and tree heights with a clinometer. Wood cores that aided in estimating the age of the stands were obtained with increment borers.

RESULTS

Each of the tables summarizes an important category of dominant plants: Table I, trees; Table II, seedlings; Table III, saplings; Table IV, shrubs and

Table I. Per cent basal area (BA) and per cent tree stems in each size class; size classes have the following dbh in inches: 1=1-3.9, 2=4-11.9, 3=12-23.9, 4=24 and over 24. Stands are arranged in descending age from left to right.

	Stand 1					Stand 2					Stand 3				
SPECIES	BA	Size Class				BA	Size Class				BA	Size Class			
		1	2	3	4		1	2	3	4		1	2	3	4
Fagus grandifolia	50	39	29	62	85	26	25	3	48	37	8	7	6	10	--
Fraxinus spp.	3	--	5	2	7	21	10	28	21	5	23	--	19	34	--
Quercus alba	2	--	--	5	--	10	20	2	4	37	3	--	6	2	--
Ulmus rubra	6	5	16	--	--	16	20	33	--	--	11	36	14	5	--
Platanus occidentalis	--	--	--	--	--	1	--	--	2	5	12	--	8	16	29
Acer negundo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aesculus glabra	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Juglans nigra	1	--	2	--	--	4	--	8	2	--	6	--	8	7	--
Acer rubrum	8	5	10	7	--	4	15	5	--	--	3	--	8	2	--
Acer saccharum	9	5	24	2	--	5	10	8	2	5	2	7	2	--	--
Quercus rubra	1	--	--	2	7	2	--	--	---	5	3	--	2	5	--
Prunus serotina	--	--	--	--	--	1	--	2	--	--	3	14	2	--	--
Ulmus americana	--	--	--	--	--	--	--	--	--	--	2	7	2	--	--

vines; and Table V, herbaceous plants. Minor species encountered in the Wissahickon woodlands and along the Sandy Run are listed in the Appendix.

A total of 42 tree species were recorded in the measurements and are considered here on the basis of dominance and constance. *Dominance* is defined as having 10 per cent or more of the basal area or per cent of stems in a given stand. Species with a high *constance* appear in 50 per cent or more of the stands. *Associate species* are those trees with less than 10 per cent of the basal area in every stand but which have high constance.

The stands have been tabulated from left to right on the basis of their estimated ages (Tables I - V). While cores furnished the estimated age for ashes (*Fraxinus americana* and *F. pennsylvanica*) in the dominant size class of each stand, in most instances this information gave only a partial picture of stand age. Therefore, observations of stand structure, historical information, and core data from other species were combined to postulate a sequence of the stands' relative ages. Stand 1 is approximately 90 years old and stands 2, 3, 4, 5, 6, and 7 are about 70, 55, 50, 50, 50, and 25 years respectively.

Stand 1 has a canopy 90-100 feet tall and is dominated by beech (*Fagus grandifolia*) (Table I). Beech reproduction consists entirely of seedling-and sapling-sized root sprouts. Seedling-size sprouts are rare (Table II) and are found only in this stand. Sapling-size sprouts are more abundant and, along with the ashes are important constituents of tree reproduction (Table III). Other trees characteristic of stand 1 are tuliptree (*Liriodendron tulipifera*), sugar maple (*Acer saccharum*), and red maple (*A. rubrum*). Tuliptree seedlings are lacking and the mature trees of about the same diameter and age occur in groups. Sugar maple constitutes 18 per cent of the seedlings and 19 per cent of the saplings and is consistently important in all but the largest size class.

Stand 4					Stand 5					Stand 6					Stand 7				
BA	Size Class				BA	Size Class				BA	Size Class				BA	Size Class			
	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4
3	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
32	10	42	42	--	13	--	11	22	10	86	14	93	75	--	54	38	50	68	--
--	--	--	--	--	--	--	--	--	--	2	--	--	6	--	--	--	--	--	--
7	3	8	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
14	3	--	21	100	10	--	--	15	60	--	--	--	--	--	--	--	--	--	--
26	70	29	7	--	39	69	42	26	--	1	--	--	3	--	--	--	--	--	--
--	--	--	--	--	10	19	20	9	--	--	--	--	--	--	--	--	--	--	--
3	3	2	--	--	4	--	9	2	--	1	--	2	--	--	35	33	40	29	--
1	--	2	2	--	--	--	--	--	--	--	--	--	--	--	3	14	--	--	--
1	7	--	--	--	1	--	--	2	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	4	--	2	9	--	--	--	--	--	--	--	--	--	--	--
1	--	2	--	--	2	4	4	--	--	--	--	--	--	--	3	5	6	--	--
7	3	5	10	--	1	--	2	--	--	--	--	--	--	--	1	--	2	--	--

There are two levels of shrub development in this mature stand. The upper stratum averages 6 feet and is dominated by spicebush (*Lindera benzoin*) while the lower layer is characterized by poison ivy (*Rhus radicans*), Virginia creeper (*Parthenocissus quinquefolia*), Japanese honeysuckle, (*Lonicera japonica*), and grape (*Vitis spp.*) between 1 and 2.5 feet tall. Grape, while climbing to heights at the edge of the stand, did not develop beyond the lower shrub stratum in the stand's interior. *Alliaria officinalis*, *Podophyllum peltatum*, and *Impatiens biflora* dominate the spring aspect of the herb layer with the latter species concentrated in the wet spots.

In stand 2 beech, ash, white oak (*Quercus alba*), and red elm (*Ulmus rubra*) dominate forming a 70 to 85 foot canopy that is less dense than in beech-dominated stand 1 across the stream. Ash dominates the seedlings followed by sugar maple while white oak and red elm have low values or are absent. Root sprouts of beech dominate the saplings followed by ash, red and sugar maples, red oak (*Quercus rubra*), and the understory tree, American hornbeam (*Carpinus caroliniana*). Again, the shrubs and vines are found in 2 distinct layers with spicebush, averaging 6 feet, composing the upper layer and poison ivy, Virginia creeper, and Japanese honeysuckle forming a 1 foot tall lower layer. Grape reaches heights of 35 feet where the canopy is thin. Herbaceous species with frequencies of 20 per cent or more are *Alliaria officinalis*, *Arisaema triphyllum*, *Asarum canadense*, *Laportea canadensis*, *Circaea quadrisulcata*, *Smilacina racemosa* and *Solidago caesia*.

Stand 3 has the most complex land surface of the woodlands studied. It is bounded on 3 sides by a loop of the creek and is dissected by many small dry channels and small tributary streams. This heterogenous and relatively unstable habitat supports an 80 to 90 foot canopy, composed primarily of ashes, red elm, and sycamore. Although the ashes are the principle canopy dominants, these two species are absent from the 1-3.9 inch class which is dominated by red elm and black cherry (*Prunus serotina*). Ashes are

Table II. Tree seedlings constituting five per cent or more of the seedlings in a given stand or which appear in three or more stands.

Species	Frequency (%)						
	1	2	3	4	5	6	7
Staphlea trifolia	7	–	–	–	–	–	–
Acer saccharum	18	7	–	–	–	–	–
Carya cordiformis	1	<1	7	–	–	–	–
Fraxinus spp.[a]	63	84	75	95	50	100	98
Ulmus spp.[b]	7	–	2	2	–	–	–
Acer platanoides	–	–	3	4	1	–	–
Prunus serotina	–	<1	7	–	2	–	–
Acer negundo	–	–	–	–	45	–	–
Total stems/acre	7,666	19,792	3,903	2,787	7,805	25,336	10,593

[a] *Fraxinus americana* and *F. pennsylvanica*.

[b] *Ulmus americana* and *U. rubra*.

Table III. Species having more than 10 per cent of the saplings in a stand. Presence of the species is indicated by p.

Species	Frequency (%)						
	1	2	3	4	5	6	7
Fagus grandifolia	19	41	–	–	–	–	–
Fraxinus spp.[a]	29	12	–	–	4	100	–
Acer negundo	–	–	p	89	96	–	–
Juglans nigra	–	–	–	p	–	–	100
Total stems/acre	1,463	1,185	418	627	1,941	70	209

[a] *Fraxinus americana* and *F. pennsylvanica*.

most prominent among the seedlings, while black cherry has 66 per cent of the saplings. Shrubs and vines again occur in 2 strata. The upper stratum is from 5.5 to 8 feet tall with spicebush at the lower end of this range and grape at the upper end. The lower stratum is about 1 foot tall and is composed primarily of Japanese honeysuckle, Virginia creeper and poison ivy. Herbaceous species with frequencies of 20 per cent or more are *Alliaria officinalis*, *Impatiens biflora*, *Geum canadense*, *Laportea canadensis*, *Hesperis matronalis*, *Convolvulus sp.*, and *Ambrosia trifida.*

Stand 4 is located on a section of the flood-plain with only a few surface irregularities. The 70 to 80 foot canopy is discontinuous and is dominated by ashes and sycamore. The other dominant tree, box elder (*Acer negundo*), forms a second layer which is best developed under the gaps in the canopy. This lower layer varies between 30 and 40 feet in height and is not an understory but rather clusters of younger trees in about the same stage of development. Ninety-five per cent of the seedlings, but no saplings, are ash; box elder dominates the saplings but has no seedlings. Shrubs and vines once again occur in 2 strata. Spicebush and grape are from 5 to 6 feet tall while Japanese honeysuckle, Virginia creeper, and poison ivy form a layer less than 1 foot tall. Herbs having frequencies of 20 per cent or more are *Alliaria officinalis*, *Impatiens biflora*, *Laportea canadensis*, and *Hesperis matronalis.*

Stand 5 is located on a small island and a neighboring section of the mainland. The canopy is about 80 feet tall on the island but is lower and less closed on the mainland. Box elder, ashes, sycamore and Ohio buckeye (*Aesculus glabra*) are the dominants. Sycamore distribution is concentrated along the stream banks while the other dominants are dispersed to varying degrees throughout the stand. The area is unique because Ohio buckeye is established and reproducing. (Pearson, 1966). Sycamore is absent from the seedlings whereas ash and box elder together account for over 90 per cent of them. Buckeye seedlings are present in small amounts. Among saplings, the pattern of reproduction is different. Ninety-six per cent are box elder. There are small amounts of ash and smaller still of Buckeye. This stand does not

Table IV. Frequency and constance of shrub and vine species.

Species	Frequency (%)							C (%)
	1	2	3	4	5	6	7	
Lindera benzoin	72	40	84	60	8	20	4	100
Rhus radicans	44	72	56	44	36	80	32	100
Parthenocissus quinquefolia	40	8	12	24	12	20	12	100
Lonicera japonica	12	8	36	36	24	–	32	86
Vitis spp.	16	8	16	8	4	–	–	72
Cornus racemosa	8	–	–	–	8	–	4	43

Table V. Herbaceous species having a frequency of at least 20 per cent. Presence indicated by p.

Species	Frequency (%)						
	1	2	3	4	5	6	7
Alliaria officinalis	24	60	80	92	44	20	56
Impatiens biflora	32	16	28	40	60	–	64
Arisaema triphyllum	16	20	12	12	–	13	8
Geum canadense	–	4	40	12	32	60	84
Asarum canadense	4	48	20	16	–	–	–
Amphicarpa bracteata	4	–	4	4	–	–	4
Viola eriocarpa	36	–	12	–	68	–	16
Oxalis sp.	–	–	8	4	4	–	8
Urtica dioica	–	–	4	4	40	–	40
Laportea canadensis	p	36	20	28	4	–	–
Hesperis matronalis	–	–	20	–	–	–	–

Fig. 2. *Carya tomentosa*, the Moekernut Hickory, is one of the minor species along the upper Wissahickon.

have 2 layers of shrub development, but rather a single one of poison ivy, Virginia creeper, and Japanese honeysuckle all with heights of 2 to 4 feet. Herbaceous species with frequencies greater than 20 per cent are *Alliaria officinalis*, *Impatiens biflora*, *Geum canadense*, *Viola eriocarpa*, and *Urtica dioica*.

Stand 6 with its uniformly-aged canopy rising to a height of 85 feet is completely dominated by the ashes. It occurs on a poorly drained loop of Sandy Run and is subject to frequent flooding. Cores show the ashes are all about 50 years old. Understory is sparse and ashes dominate tree reproduction there being no other species recorded among the seedlings and saplings. The shrub layer is dominated by poison ivy which forms a thick layer to a height of 1 foot and is interspersed with a scattering of Virginia creeper. Spicebush, scattered singly and in small clumps, reaches to about 6 feet at irregular intervals. Herbs are sparse with only *Alliaria officinalis* and *Geum canadense* having frequencies of 20 per cent or more.

Stand 7 is developing on a former meadow. The dominant trees are ashes and black walnut (*Juglans nigra*), but they usually are not intermingled. There is no subcanopy in this park-like stand, but the canopy rises to heights of 50 to 60 feet. Seedling reproduction is almost exclusively ash with a few walnuts, but all saplings recorded were walnut. Vines of poison ivy, Virginia creeper, and Japanese honeysuckle are common to heights of 1 foot but are frequently overtopped by the taller herbs. Scattered individuals of spicebush and gray dogwood (*Cornus racemosa*) vary from 4 to 6 feet in height. Herbaceous species with frequency greater than 20 per cent are *Alliaria officinalis*, *Impatiens biflora*, *Geum canadense*, *Urtica dioica*, *Allium spp.* (32%), and *Convolvulus sp.* (20%). Of these, *Urtica* up to 3 feet tall is more prevalent in the walnut areas than the ash areas while *Alliaria* is concentrated where ash predominates.

DISCUSSION

There are several patterns of tree distribution that appear to be correlated with age of stand (Table I). The first pattern consists of species that have a constance of 100 per cent and which may form the matrix of the tree community in each stand. The species most outstanding in this pattern are the two ashes which are dominants in every stand except the oldest where they constitute only 3 per cent of the basal area. Black walnut is the other species that falls into the first pattern. The species is present in all stands but dominant only in the youngest stand.

A second pattern is exhibited by species that are confined to, or have their largest values in, the older stands. Such species are beech, white oak, and red and sugar maples. Red elm approaches, but does not quite fit into, this pattern. The third pattern is formed by species that have their largest basal area values in, or are largely confined to, stands of intermediate age. These species are sycamore, black cherry, American elm (*Ulmus americana*), and pin oak (*Quercus palustris*).

A final pattern is formed by those species which are confined to, or have their largest values in, the younger stands. The ashes and walnut would be placed in this group if it were not for their distribution in all other stands. The two species which best fit this last pattern are buckeye and box elder.

The reasons for these distribution patterns can be postulated on the basis of the species' known characteristics recorded in Harlow and Harrar (1958) and Fowells (1965). Thus the ashes have their greatest basal area and successful reproduction in the younger

stands where rapid growth is possible under conditions of ample light. Again, light is important in influencing the development and successful establishment of black walnut, an extremely intolerant species. Beech, a very shade-tolerant species, has all its reproduction confined to stands 1 and 2; the oldest stands with well-developed canopies. This suggests that beech, slow in becoming established, tends to maintain itself by shading out its less tolerant competitors. White oak achieves dominant status only in stand 2 and, with the exception of a few seedlings in this same stand, is not reproducing. The scattered occurrence and lack of reproduction suggests that white oak may maintain itself by exploiting the occasional openings that occur in these woodlands. Red maple is also located primarily in the older stands with the exception of stand 7 where reproduction was concentrated in a grove along the border of a swampy area. It is in the two oldest stands that red maple reaches its greatest prominence and is reproducing successfully. The pattern of sugar maple is much the same as that of red maple and it seems probable that this shade-tolerant species will maintain itself and increase in importance in the maturing flood-plain woodlands.

Tree species not contributing greatly to the communities but occurring beyond their natural ranges are Norway maple (*Acer platanoides*), tree-of-heaven (*Ailanthus altissima*), Osage orange (*Maclura pomifera*), alder (*Alnus glutinosa*), scots pine (*Pinus sylvestris*), buckeye, and sweetgum (*Liquidambar styraciflua*). The pines are known to have been planted along a stream-side trail about 1920 (Mrs. James Miller, personal communication). Buckeye and sweetgum occur together on an island where a partially buried wall leads to the suspicion that they were planted. The sweetgum is a solitary stem of 18 inches dbh and 79 feet tall while buckeye has become established in a grove where the species has many stems of various sizes. (Pearson, 1966). Norway maple appears to be becoming naturalized in several of the stands. The species contributes small amounts to the basal area in stands 3 and 1, is an important sapling in stand 3, and appears in the seedling count of stands 3, 4, and 5. This species is a common street tree in areas bordering sections of the flood-plain and its samaras permit the widespread distribution of the species throughout the narrower section of the plain. The incorporation of this shade-tolerant species into the flood-plain communities should, in time, alter their composition. The tendency of *Alnus glutinosa* to escape from cultivation has been noted by Gleason (1952). Along the stream-side margin of stand 3 the species is represented by scattered shrubs, small trees, and a single tree of 8 inches dbh. Thus the evidence points to the eventual establishment of *A. glutinosa* along the stream banks of stand 3. The single occurrence of Osage orange also probably represents an escape from cultivation.

Fig. 3. *Quercus alba*, the White Oak, is an important component of the upper Wissahickon flood-plain.

The shrub and vine components of these communities are characterized by the species listed in Table IV. Spicebush dominates increasingly as stands grow older. Other shrubs whose presence as scattered individuals is of interest are *Berberis thunbergii*, *Lonicera tatarica*, and *Euonymus alatus*. According to Gleason (1952), these escape from cultivation relatively frequently in the case of *Berberis* and quite rarely in the case of *Euonymus*. Another probable escape from cultivation is the *Viburnum opulus* in stand 3 that is well to the south of its natural range (Grimm, 1957).

Ten of the herbs recorded in the stands have constance high enough to be considered characteristic of these communities. The most ubiquitous is *Alliaria officinalis* closely followed by *Impatiens biflora*, *Arisaema triphyllum*, and *Geum canadense*. Other common species are *Asarum canadense*, *Amphicarpa bracteata*, *Viola eriocarpa*, *Oxalis sp.*, *Urtica dioica*, and *Laportea canadensis*. The remaining species in Table V are distributed in various ways among the stands and include species that were recorded in no more than one stand. In such a limited geographical area as the Wissahickon flood-plain with its unstable habitat, it is hard to explain these distributions other than by chance.

It is difficult to make a definite statement about community types on the basis of only seven stands differing in age and history. However, features that stand out and suggest a probable community type are: 1) There are 13 trees species that dominate the

stands in some combination. 2) The two species of ash unify the stands by being dominants or codominants in all but one stand (No. 5). 3) Ashes, while dominating basal area in the young and intermediate aged stands, yield to beech dominance in the older stands. Thus woodland communities on the floodplains of the Wissahickon and its tributaries can best be described as mixed hardwood communities with species dominance changing from ash to beech when the area has been stable long enough to develop a mature stand.

If the results are compared to the works of other authors, certain other features of the Wissahickon vegetation stand out. Gordon (1941) quotes Darlington as saying in 1837 that sugar maple was a rare tree occurring in the rich woods along the Brandywine. Although that location is not far from the southern border of sugar maple's range as mapped by Harlow and Harrar (1958), sugar maple, while not a dominant, is far from being a rare tree along the Wissahickon now. Harshberger (1904) states that black walnut, tuliptree, white (American) elm, sycamore, and red and sugar maples have their best development on alluvial soils in southeastern Pennsylvania. Trees listed by Harshberger as being typical of stream banks include beech, red maple, sycamore, American hornbeam (*Carpinus caroliniana*), pin oak, sassafras (*Sassafras albidum*), birches (*Betula*) and willows (*Salix*). Since nearly all these species are found in one or more of the Wissahickon stands, one cannot exclude the possibility that they were much more important in other locations on the flood-plain that have been cleared. Four of the species listed by Sigafoos (1961) as being predominant in a stand on the Potomac flood-plain are also important in the Wissahickon stands. These are red elm, sycamore, box elder, and ash. Silver maple, willow, and river birch (*Betula nigra*), also listed by Sigafoos as predominant are occasionally seen along the Wissahickon. Thus the difference between Sigafoos's description and the Wissahickon stands is one of quantity, not quality.

When comparing the Wissahickon stands with stands studied on the Raritan flood-plain by Wistendahl (1958) and Buell and Wistendahl (1955), basic similarities of tree species composition are apparent. They found the outstanding species to be beech, ash, sycamore, and elm (*Ulmus americana* and/or *U. rubra*); and that sugar maple, bitternut hickory (*Carya cordiformis*); and red maple are important. They noted that beech had its best development in stands that were rarely inundated and that ashes (*F. americana* and/or *F. pennsylvanica*) were important in all the stands they studied. In both the Wissahickon and Raritan communities, the development of sugar maple, sycamore, elms, white oak, box elder, and red maple is similar in reference to age-of-stand and location on the flood-plain. Differences are seen in the greater development of bitternut hickory and pin oak. Neither of these species has developed on the Wissahickon to the extent noted by Wistendahl (1958) or by VanVechten (1959) on the Millstone River.

Fig. 4. *Aesculus glabra*, the Ohio Buckeye, has become established in the upper Wissahickon floodplain.

Composition of the shrub layer is similar on the Wissahickon, Raritan and Millstone flood-plains. Spicebush is the leading shrub on the Wissahickon and on the Raritan. VanVechten (1959) also found this species to be most important in the older stands along the Millstone. Other species noted by these authors as being characteristic of flood-plain communities are poison ivy, Virginia creeper, and Japanese honeysuckle. While there are differences in the total shrub and vine flora on the three flood-plains, the characteristic species remain the same.

As would be expected due to the different size and diversity of the sites, herbaceous species on the three flood-plains vary widely. However, 20 of the 63 species listed by Wistendahl (1958) for the outer

flood-plain of the Raritan are present in the stands on the Wissahickon as are 7 of the 27 species listed by VanVechten (1959) as being common in the older forested areas along the Millstone.

While the general forest pattern and composition on all these flood-plains are similar, the Wissahickon seems to have a greater chance for future change. The potential compositional changes lie in the exotic species such as Ohio buckeye, Norway maple, *Alnus glutinosa*, and Japanese honeysuckle, all of which are established and reproducing.

ABSTRACT

Seven woodlands were surveyed along the flood-plain of Wissahickon Creek, Montgomery County, Pennsylvania. The mixed hardwood stands were characterized by *Fagus grandifolia*, *Fraxinus americana*, *F. pennsylvanica*, *Quercus alba*, *Platanus occidentalis*, *Acer negundo*, and *Juglans nigra*. The younger stands were dominated by *Juglans* or *Fraxinus spp.*, the intermediate-aged stands by mixed hardwoods with *Fraxinus spp.* predominating, and the older stands by *Fagus*. *Lindera benzoin* was the most prominent shrub and increased in dominance in older stands. *Rhus radicans*, *Lonicera japonica*, *Parthenocissus quinquefolia*, and *Vitis spp.* were frequent in areas where light penetrated the canopy. The most frequently encountered herbs were *Alliaria officinalis*, *Impatiens biflora*, *Arisaema triphyllum*, *Geum canadense*, *Amphicarpa bracteata*, *Laportea canadensis*, *Oxalis sp.* and *Viola spp.* Two exotic trees, *Aesculus glabra* and *Acer platanoides*, are present and reproducing indicating the possibility of future changes in the composition of these stands.

APPENDIX

Minor species found in the woodlands along the Wissahickon and Sandy Run.

TREES

Acer platanoides	Norway Maple
A. saccharinum	Silver Maple
Ailanthus altissima	Tree-of-heaven
Alnus glutinosa	Black Alder
Amelanchier sp.	Serviceberry
Betula nigra	River Birch
Carpinus caroliniana	Ironwood
Castanea dentata	Chestnut
Carya cordiformis	Bitternut Hickory
C. ovalis	Pignut Hickory
C. ovata	Shagbark Hickory
C. tomentosa	Mockernut Hickory
Catalpa speciosa	Catalpa
Cornus florida	Flowering Dogwood
Crataegus spp.	Hawthorn
Juglans cinerea	Butternut
Liquidambar styraciflua	Sweetgum
Maclura pomifera	Osage Orange
Nyssa sylvatica	Black Gum
Ostrya virginiana	Hop Hornbeam
Prunus avium	Sweet Cherry
Pinus sylvestris	Scots Pine
Quercus palustris	Pin Oak
Q. velutina	Black Oak
Staphylea trifolia	Bladdernut
Tilia americana	Basswood
Tsuga canadensis	Hemlock

SHRUBS AND VINES

Amorpha fruticosa	Indigo Bush
Aronia sp.	Chokeberry
Berberis thunbergii	Japanese Barberry
Celastrus scandens	Bittersweet
Clethra alnifolia	Sweet Pepper Bush
Cornus amomum	"Red Willow"
Euonymus alatus	Winged Euonymus
Gaylussacia baccata	Huckleberry
Lonicera tatarica	Tartarian Honeysuckle
Rubus occidentalis	Bramble
Sambucus canadensis	Common Elder
Viburnum acerifolium	Maple-leaved Viburnum
V. cassinoides	Witherod
V. opulus	Guelder Rose
V. prunifolium	Black Haw

HERBS

Allium spp.	Onion
A. tricoccum	Wild Leek
Ambrosia trifida	Giant Ragweed
Arisaema dracontium	Dragon Root
Aster divaricatus	Aster
Athyrium filix-femina	Lady Fern
Bidens sp.	Bur Marigold
Boehmeria cylindrica	False Nettle
Circaea quadrisulcata	Enchanter's Nightshade
Cirsium spp.	Thistle
Collinsonia canadensis	Horse Balm
Convolvulus sp.	Bindweed
Cryptotaenia canadensis	Honewort
Echinocystis lobata	Wild Cucumber
Equisetum arvense	Common Horsetail
Erigeron annuus	Daisy Fleabane
Eupatorium rugosum	White Snakeroot
Fragaria sp.	Strawberry
Galium aparine	Bedstraw
Geranium maculatum	Spotted Cranesbill

Glechoma hederacea	Ground Ivy	*Prunella vulgaris*	Selfheal
Hemerocallis flava	Yellow Day-Lily	*Ranunculus ficaria*	Lesser Celandine
Hesperis matronalis	Dame's Violet	*Rumex crispus*	Dock
Mertensia virginica	Bluebells	*Sanguinaria canadensis*	Bloodroot
Monotropa uniflora	Indian Pipe	*Sanicula canadensis*	Black Snakeroot
Onoclea sensibilis	Sensitive Fern	*Smilacina racemosa*	False Solomon's Seal
Pedicularis sp.	Lousewort	*Solanum carolinense*	Horse Nettle
Phytolacca americana	Pokewood	*S. dulcamara*	Nightshade
Pilea pumila	Clearweed	*Solidago caesia*	Blue-Stem Goldenrod
Podophyllum peltatum	May Apple	*S. gigantea*	Giant goldenrod
Polemonium reptans	Jacob's Ladder	*Steironema ciliatum*	Loosestrife
Polygonatum biflorum	Soloman's Seal	*Symplocarpus foetidus*	Skunk Cabbage
Polygonum sagittatum	Arrow-Leafed Tearthumb	*Thalictrum sp.*	Meadow Rue
Polystichum acrostichoides	Christmas Fern	*Tovara virginiana*	Jumpseed
Prenanthes sp.	Rattlesnake Root	*Verbena urticifolia*	White Vervain

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ARBORETUM MANAGER APPOINTED

Gordon A. Brandes has been appointed by the Advisory Board of Managers to the position of Manager of the Morris Arboretum. In this newly created post, Mr. Brandes will be responsible for the operation of the Arboretum and its management and will report to the Provost of the University of Pennsylvania. Major duties will be to organize and direct the operations of the Arboretum to its best interest and that of the University. He will assume full responsibility for developing and maintaining effective programs in community relations, cooperation with other institutions such as schools, colleges, the Extension Service, and the Pennsylvania Horticultural Society.

In addition to supervising all operating and staff activities at the Arboretum, a substantial effort will be devoted to forward planning for immediate and long range needs for funds, operations, facilities and the development of managerial and staff talent.

Mr. Brandes obtained his B.S. degree in Botany at the North Dakota State University. He was employed as a conservationist with the U.S. Soil Conservation Service and as Research Director of Agsco, Inc., Grand Forks, North Dakota. Before coming to the Arboretum, he completed 25 years with Rohm and Haas Company, Philadelphia in various positions associated with Agricultural Chemical Product Development.

Mr. Brandes has travelled extensively throughout the U.S., Canada, and Europe to all major crop producing areas and Agricultural Research Stations. He is a recognized authority on the use and application of crop protection chemicals and a frequent guest speaker and writer on these and related topics on food production, population and environmental preservation.

He has been an officer and active on numerous committees of the American Phytopathological Society, and a member of the American Institute of Biological Sciences, the American Association for the Advancement of Science, the Entomological Society of America and the Weed Science Society of America.

Mr. Brandes has maintained a lifelong interest in gardening and music and has played leading roles in a number of amateur musical comedy productions. He resides with his family at 1009 Serpentine Lane, Wyncote, Pennsylvania.

Dr. Li will remain in the posts of Director of the Morris Arboretum and Professor of Botany at the University of Pennsylvania with responsibilities for the Arboretum's academic programs associated with the Department of Biology, as well as overall responsibility for furthering the development of the botanical research activities of the Arboretum's staff.

COURSES IN BOTANY AND HORTICULTURE FOR THE FALL, 1972

The Morris Arboretum offers nontcchnical courses on basic botany and horticulture that are designed for the Associates of the Arboretum and the general public. Each of them consists of six sessions that combine lectures, demonstrations, and practical expericnces. Several courses are offered every Fall and Spring. You may select those that interest you most or may follow a plan of organized study that will earn the Botanical School Certificatc. Thc beginner is advised that course number 01, Organization and Function of Plants, or equivalent knowledge, is fundamental to most of the other courses (02, 05, 06, 09, 10, 11, 12, 13).

For the Fall, 1972

01. ORGANIZATION AND FUNCTION OF PLANTS. DR. A. O. DAHL.

An introduction to the structure of flowering plants; how roots, stems, and leaves, flowers, fruits and seeds function; and how the plants live in their environment. This course, or equivalent knowledge, is needed for most other courses.
Mondays, 8-9:30 p.m., September 25, October 2, 9, 16, 23 and 30.

15. MOSSES AND FERNS. DR. A. E. SCHUYLER, Philadelphia Academy of Natural Sciences.

An introduction to the structurc and ccology of mosses and ferns with special emphasis on those that grow nearby or may be used in gardens.
Tuesday, 10-11:30 a.m., September 26, October 3, 10, 17, 24, 31.

07. GARDENING PRACTICES. GORDON BRANDES.

The planning, construction and maintenance of the home garden.
Tuesdays, 8-9:30 p.m., September 26, October 3, 10, 17, 24, 31, or Wednesdays, 10-11:30 a.m., September 27, October 4, 11, 18, 25, November 1.

04. PLANT PROPAGATION. GERALD ABRAMS.

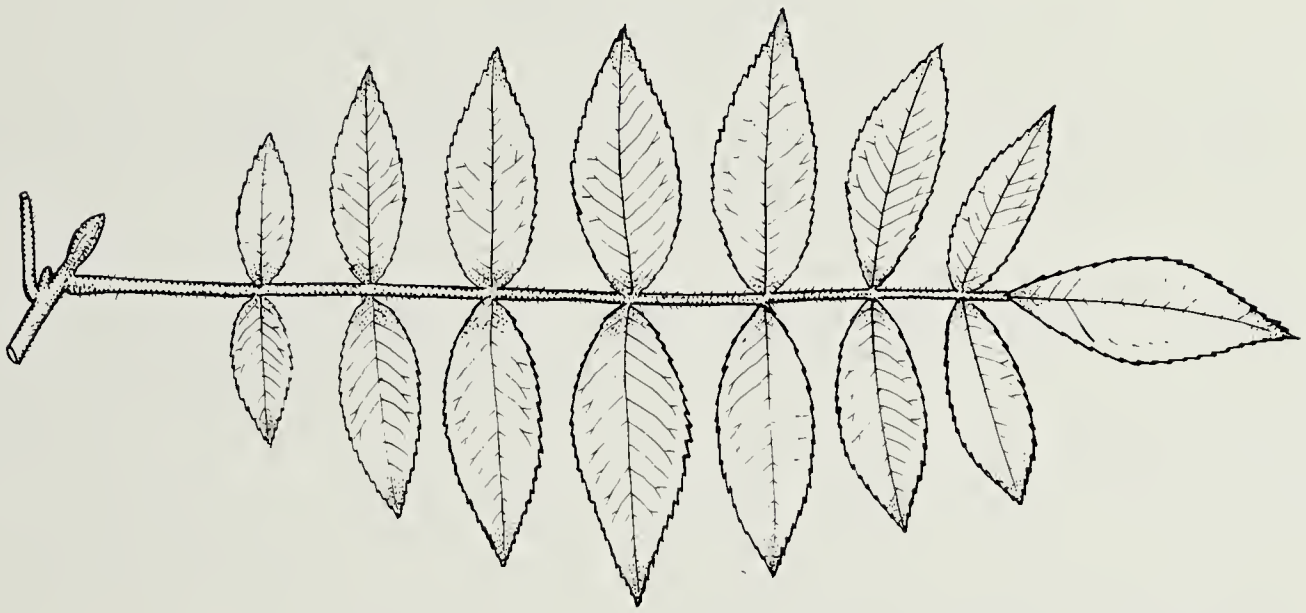
Basic procedures of propagation by seed, vegetative parts and grafting. Special emphasis will be given to plants that can be propagated in the autumn.
Wednesdays, 8-9:30 p.m., Septembcr 27, October 4, 11, 18, 25, November 1.

08. FIELD STUDY OF THE FUNGI. DR. PATRICIA ALLISON.

Recognition of important mushrooms and other fungi; also analysis of their habitats. There will be an introductory session followcd by five weekly field trips.
Saturdays; first meeting at 10 a.m., September 23 through October 28.

(Continued on page 50.)

LEAF ANALYSIS— A TOOL FOR DIAGNOSING PLANT NUTRIENT STATUS



GERALD B. ABRAMS

For many years people have been feeding the plants in their home landscape by the "handful of this and a handful of that" method. This method doesn't take into consideration the amount of nutrients the plant actually needs. The amount used could be sufficient to support the growth for the year or it could be totally inadequate. Master gardeners have been able to use this method for two reasons. They have made careful records of the amounts of materials applied and have faithfully studied the plants' responses in color, growth, flowering, and fruiting. But to adequately prescribe a fertilization program, a more accurate tool for measuring the nutritional status of the plant is desirable. There are two additional basic methods used for assessing the nutritional status of the plant—soil analysis and plant analysis. Both methods are becoming more and more feasible for use in the private garden.

SOIL ANALYSIS

It has been recognized for years that analysis of soil alone is not always a satisfactory guide for fertilization of perennial plants. When a soil analysis is performed, the nutrients are extracted chemically. Some falsely conclude that the nutrients so obtained are readily available, and that the nutrients that could be taken up by the plants would be directly correlated. This may be so for some nutrients and for some crops growing on specific soils, but it is not universally true. The analysis of soil fails to reveal the bonding power of different clays for various mineral elements, the effects of one nutrient on another, the concentration and movements of minerals in the water solution in the soil, and the differential feeding capacity of plant roots. The soil analysis tells nothing about the volume of the soil which the roots are penetrating. It also tells nothing about the concentration of nutrients available to the plants in portions of the soil not sampled (1).

Soil analysis is beneficial because it will indicate the presence or absence of a particular element in the soil, but it will not indicate the availability of that element to the plant (3).

LEAF ANALYSIS

Because soil analysis has so many limitations, another method or combination of methods must be considered. In recent years, plant analysis has been

adopted as a technique for determining the status of the nutrient levels in the plant tissue. This method is not really new, as its foundations were laid down by Weinhold in 1862. It is really a variation on the technique of the master gardener, only now a really close look is given to the plant. Instead of noting color or growth or flowering, the actual mineral content of the leaf is assessed.

Leaf analysis is based on the conclusions that (a) plant metabolism is especially high in the leaves; (b) the composition of the leaves reflects the nutrient supply; (c) changes are more pronounced at certain stages of development than at others; and (d) that the concentrations of nutrients in the leaf at specific growth stages are related to other aspects of performance of the crop such as yield (1). As far back as 1869 it was noted that if necessary information is first obtained by field trials, crop analysis would provide a satisfactory basis for the determination of both relative and absolute proportions of plant nutrients present and available in the soil. This would give the information needed to evaluate the results of ordinary chemical soil analysis. This hypothesis appeared valid because there were data to indicate that the mineral content of the plant has some controlling influence on growth and fruitfulness.

The researchers first using plant analysis as a diagnostic technique assumed that if factors such as sunlight, temperature, and water were not limiting growth, then a sampling of the leaf tissue would give a key to the appropriate nutrient supply that was limiting growth (13). As the technique grew in popularity other factors were studied on the list of external forces which might confuse the data received from leaf analysis. These additional factors include insects, nematodes, disease, and soil structure (12).

The leaf is not the only tissue that will reflect the nutritional status of the plant, but it is usually the best for most elements. In fact, the leaf is the focal point of many plant functions, and is relatively sensitive as an indicator for those mineral elements that directly affect photosynthesis. The most practical reason for using leaves is because they are the most convenient portion of the plant to sample (11). In citrus, fifty per cent of the total minerals are found in the leaves thus indicating the importance of this organ for sampling and analysis (2).

Leaf analysis is used more widely in perennial than annual plants because woody crops are relatively slow growing, and have long periods of absorption, accumulation, and transport of minerals interposed between mineral loss and quiescense. A response to nutrient treatments applied to the soil may take several years to be detected, but this is a short period compared to the fifty to one hundred years a tree may be in one location (12).

Analysis of all plant parts is undesirable because minerals that accumulated in inactive tissues and are unavailable for plant use may mask functional shortages elsewhere in the plant that might actually be limiting growth (10).

In studies done on strawberries to determine the plant part most indicative of nutrient requirements, it was found that the leaf yielded results as sensitive or more sensitive than from any other fraction. Frequent sampling of cotton during the growth period revealed that the composition of the leaf reflected the status of the entire plant better than the stems and roots (5).

Many tests have been made to find out the stage at which the leaf could best be sampled. Analysis shows that there are three general periodic effects of leaf age on mineral content. First, there is a high state of change in young leaves during expansion and shortly thereafter because metabolic processes are high. Second, there is a period of depletion of mobile elements as senescence approaches. The third period is the intervening period of a few weeks or months when the mineral content is relatively stable. Analyses during this intervening period are more meaningful because of less fluctuation (6). Just when this period occurs depends upon the species of plant and the part of the world in which it grows. For example Jones and Embleton indicated that the best time for taking lemon leaf samples in California is during August and September (8). Embleton, Jones, and Garber found that August to October is the best period for sampling avocado leaves in California in order to estimate the amount of nitrogen to be applied the following spring (7). Davidson concluded after sampling leaves of *Gleditsia triacanthos*, *Acer platanoides*, *Syringa vulgaris*, and *Euonymous alatus* that the sampling is best done in the period from June to August in Michigan (4).

Kelley and Shier determined that the period between September and mid-December was most desirable for taking samples of *Taxus media.* The nitrogen was increasing too rapidly from June to August to be a valid sampling period and after December the leaf nitrogen decreased too rapidly because of leaching and translocation (9).

Very little has been written about the size of a representative sample. Some researchers believe that thirty selected leaves can represent the nutritional status of an entire tree. Other collection procedures become even more specific. Twenty-five leaves taken from the middle of the first mature flush of growth have proven to be a satisfactory sample. For the

general analysis that most homeowners desire, leaves taken from mature growth will give an acceptable evaluation.

As was stated earlier, soil analysis is not the total answer to determining the nutrient needs of the plant, but neither is plant analysis. By coupling the results of these two methods the proper prescription for nutrient needs can be determined.

The question now comes to the mind of the home owner, "How do I get a soil and plant analysis?" In this country there are laboratories specializing in soil and plant tissue analysis. There are also soil testing services associated with the Extension Service of the Agricultural Colleges of state universities throughout the country. In Pennsylvania soil sampling kits may be obtained from county agricultural agents.

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Complete Course Listing

01.	Organization and Function of Plants	10.	Diseases and Pests of Plants
02.	Classification of Plants	11.	Conifers
03.	Molds, Mushrooms and the Environment	12.	Ornamental shrubs
04.	Plant Propagation	13.	Ornamental Trees
05.	Fundamentals of Plant Ecology	14.	Man's Uses and Misuses of Plants
06.	Important Plant Families	15.	Mosses and Ferns
07.	Gardening Practices	16.	Seminar on Local Environmental Problems
08.	Field Study of the Fungi		
09.	Breeding Plants	100.	Tutorial Botany

Tutorial Botany

The person registering for tutorial botany is given special opportunities for the independent exploration of a subject of his choice under the guidance of a staff member. The grounds, library, and laboratories will be available to such students. An understanding of plants and fungi equivalent to the completion of four courses (01, 02, either 03 or 08, and 05) is required beforehand.

The Botanical School Certificate

The Certificate of the Botanical School is awarded to those who have completed a minimum of eight courses. These must include courses 09 and 15, one elective, and at least one term of tutorial botany.

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Hui-lin Li

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MORRIS ARBORETUM

DECEMBER 1972 BULLETIN 23 (4)

The Morris Arboretum Bulletin is published quarterly at Philadelphia, Pa., by the Morris Arboretum, 9414 Meadowbrook Ave. Chestnut Hill, Philadelphia, Pa. 19118. Subscription $4.00 for four issues. Single copies $1.00. Free to Associates. Second-class postage paid at Philadelphia, Pa.

THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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Family	$15.00 a year	Sponsoring	$100.00 a year
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TABLE OF CONTENTS

CREDITS: Cover, William Wright, Arboretum gardener; Fig. 1, *The Garden*, vol. III, 1878; Fig. 2, H. L. Li, *Woody Flora of Taiwan*, 1963; Rose Signatures, Léonie Bell.

COVER: View from the steps of the rose garden belvedere toward the wintry creek.

IDESIA POLYCARPA, AN EXTRAORDINARY ORIENTAL JEWEL

A. ORVILLE DAHL

Fig. 1. An inflorescence of male flowers of Idesia polycarpa. The sepals are yellowish-green, the many anthers, orange. At peak bloom the fragrance of the flowers resembles that of Vanda orchids.

Idesia polycarpa Maxim. is a rare and handsome tree belonging to the largely pantropieal Family *Flacourtiaceae.* The single species is alone in the genus *Idesia.*

Although systematie eomposition of the family has been revised over the years with the inereased knowledge resulting from taxonomie research, it is now regarded as aneestrally the most primitive family of the Order *Violales.* With its inclusion of approximately 1,300 speeies, it is also the largest family in the order (3).

In this botanically interesting group of trees and shrubs (and a few vines), one finds in addition to *Idesia* sueh distinetive, tropieal plants as the Governors Plum, *Flacourtia indica* Merr. of southern Asia and Madagasear, the Kei Apple, *Dovyalis caffra* Warb. of South Africa, and the Ceylon Gooseberry, *D. hebecarpa* Warb. of Ceylon and India. These and additional speeies of *Flacourtia* are eultivated in Malaysia for their edible, sweet fruits (9).

Chaulmoogra (*Taraktogenos kurzii* King) of Burma and Siam, Indian Chaulmoogra (*Hydnocarpus wightiana* Blume) of India, and Chinese Chaulmoogra (*H. anthelmintica* Pierre) of Indo-China are members of this Family. The brownish-yellow oil expressed from seeds of these speeies yielded the glyeerides of chaulmoogrie and hydnoearpie aeids onee widely employed in the treatment of leprosy (5, 12). The fruit of speeies of *Hydnocarpus* and the bark of Payang (*Pangium* of the East Indies) have also been used as fish poisons (17).

The beautiful evergreen serambling shrub with pendant crimson-red flowers, *Berberidopsis corallina* Hook. f., of Chile also belongs to the *Flacourtiaceae.* This speeies has long been cultivated in mueh-sheltered loeations in England (11).

Idesia polycarpa, having the oriental name Shan T'ung Tzu (15), is a broad-headed, deeiduous tree of moderate size (up to approximately 15 meters or 45 feet in height). Speeimens ean be grown with either single or multiple trunks. The speeies is native to eentral and western China and southern Japan (7, 15). Wilson (18) observed native, small-sized trees as "fairly common in plaees" during his travels in China. It has long been eultivated as an ornamental shade tree in eastern Asia and was introduced into eultivation in Europe by the Russian botanist Maximowiez in 1864.

The broadly ovate leaves of *Idesia* are somewhat reminiseent of vigorously large poplar leaves. Autumn eoloration merely to the extent of a yellowish green tone is all that has been observed in our Morris Arboretum speeimen, but this, in eombination with a paler, grayish underside is a unique, subtle adornment for a brief period.

The fragrant, yellowish-green flowers, appearing in May and June, are borne in pendulous clusters (panicles) Fig. 1. Structurally, the flowers, about 1.5 cm. (ca. 5/8 in.) in diameter, are without petals and are typically unisexual with the staminate or pistillate flowers being borne on separate trees (i.e. the dioecious state). There are reports (2, 13) of occasional specimens producing perfect (bisexual) flowers as well as one kind of unisexual flowers (i.e. the polygamous state). This may be true of the Morris Arboretum specimen because it forms fruit even though there is no staminate-flowered tree in the collection.

The spectacularly decorative feature of the tree lies in the abundant graceful, pendulous clusters of long-lasting fruits (Fig. 2). These are globular berries, each about the size of a pea on long pedicels borne in distinctively ornamental clusters approximately 25 cm. long (10 in.). The gradual ripening of the fruit that begins in September provides an interesting sequence of color changes. At the time the foliage is turning yellowish green, the fruits are of a similar color. With the shedding of the leaves, the berries become yellowish orange then finally change to red of unusual brilliance which is still of remarkable attractiveness in our Arboretum specimen in mid-December. Our specimen is also interesting for its light gray bark with numerous cinnamon brown lenticels.

Several botanical varieties of *I. polycarpa* have been listed by various botanists (1, 11, 15, 7). These include: var. *vestita* (with leaves softly hairy beneath, reported (14) to come true from secd.); var. *crispa* (with curiously cut and crisped leaves); var. *folius variegatus* (leaves variegated with yellow and gray); var. *microcarpa* (with fruit half the size of the type); and var. *typica.*

Long ago, Rehder (13) reported that plants raised from seeds collected in central China were hardy in favorable positions at the Arnold Arboretum (Jamaica Plain, Mass.) while Japanese plants introduced 50 years earlier were not hardy north of Philadelphia. The tree is scarce in forests of Taiwan at medium to high altitudes (1300–2300 meters) (7). While the species is rated as a Zone 6 (13) plant capable of survival in regions where the average annual minimum temperature falls within the range -5° to 5° F., it is possible that judicious selections from seedling populations from new seed sources, including collections from higher elevations, could yield quite desirable new variants having increased tolerance to winter temperatures.

Propagation is by seeds which germinate readily (1, 14). The seeds from the many-seeded berry are 2–3 mm. long, of a silvery-olive color, and are rather similar in size and shape to those of *Viola.* The outer covcring of the sced is made up of thin-walled colorless, rather transparent cells while the inner layer of the seed coat is of heavy-walled cells of a dark purple-maroon color. There is a straight, well-developed embryo surrounded by the food (endosperm) tissue.

The seedlings grow rapidly while young but it is not possiblc to distinguish the staminate and pistillate individuals until flowering is attained. However, it is possible to obtain new plants from mature specimens by propagation from green wood or root cuttings and by layering. This procedure would be essential where highly selected varieties are involved.

The pulp of the fully ripe, scarlet berries is light yellow, the color being due to the abundant globules of yellow oil in the thin-walled cells. In addition,

Fig. 2. A young cluster of Idesia polycarpa fruits. After the leaves have fallen and the long-stemmed red berries are fully mature, the graceful, drooping cluster hangs straight down.

there are nests of heavy-walled stone-cells having prominent interconnecting channels (plasmodesmata) and cells with prominent cuboidal or prismatic crystals of calcium oxalate. The presence of such poisonous crystals could lead one to be less than enthusiastic over the observation (6) that the beautiful fruits are edible. This remark referred presumably to Japanese trees and could relate to the possibility that there is genetic variation in the calcium oxalate content of the fruit produced by different varieties. However, the presence of calcium oxalate crystals in other tissues of Flacourtiaceous species has been reported by a number of botanists (10). Indeed, the nature and distribution of these crystals has often been helpful in the identification of genera and species of the *Flacourtiaceae.* Somewhat related, intensive studies of the wood anatomy (16) bear out the significant relationship between the *Flacourtiaceae* and the *Violaceae.*

The intact pollen grains of *Idesia* are about 19 to 20 microns in diameter as observed in microscopical mounts in lactic acid-triacetin and polyvinyl alcohol. Stellate crystals of calcium oxalate, probably derived from cells of the anther wall, were present in the pollen mounts. The pollen grains are elegantly shaped. There are three north to south furrows, each with an equatorial germinal pore (tricolporate). In addition, the surface is sculptured into a network of minute ridges. Such characters are not unusual since they are to be found in a fairly wide range of families. It is thus rather paradoxical that the pollen grains are suggestive of those of *Salix* (willow). On other grounds, Gilg (4) concluded that the view of deriving the willow family (*Salicaceae*) from the *Flacourtiaceae* could not be supported. With the increased number of experimental approaches made available during the past decade, it would be of interest to re-examine a number of hypotheses concerning the evolutional relationships of the *Flacourtiaceae* with other families.

The generic name, *Idesia,* commemorates Eberhard Ysbrant Ides, a Dutch statesman born in Holstein in 1660 (6). He travelled extensively in Russia and China in the service of Russia during the period 1691-1695. Following his association with Peter the Great and Emperor Khang-Hi, he published in Amsterdam in 1704 an account entitled "Voyage de l'ambassadeur moscovite E. I. Ides de Moscou a la Chine" (6).

The graciously ornamental tree commemorating Ides certainly should not be overlooked in regions where winter temperatures are comparable to those in Philadelphia.

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Associates' News

SHORT COURSES

The spring courses in horticulture and botany will begin March 19, 1973. Mr. Donald F. Scales, faculty member at the Bucks County Community College, will be joining our teaching staff this year to teach Basic Botany. Other subjects offered this session are Plant Identification; Plant Propagation; Molds, Mushrooms, and the Environment; and Gardening Fundamentals.

Please consult your newsletter, "WoodChips," for details.

ARBORETUM MONOGRAPH AUTHOR HONORED

Ida Kaplan Langman, author of one of the Morris Arboretum Monographs, was honored recently during the First Latin American Botanical Congress, held in Mexico City.

The Congress, attended by some 550 delegates from Mexico, Central America, South America, and the United States, was held in conjunction with the Fifth Congress of the Botanical Society of Mexico.

At a special formal session, the Botanical Society awarded three medals for botanical merit to persons who had made special contributions toward Mexican botany. One of these, the first to a United States citizen, honored Ms. Langman for her compilation, *A Selected Guide to the Literature on the Flowering Plants of Mexico*, published by the University of Pennsylvania Press. This work was begun at the suggestion of Dr. John M. Fogg, Jr., now director of the Arboretum of the Barnes Foundation. Support was provided for a number of years by the University of Pennsylvania Botany Department under Dr. David Goddard, by the Morris Arboretum, and by the National Science Foundation.

Soon after publication the author of the enormous compendium was the recipient of the Oberly Memorial Award Citation of the American Library Association for the "best bibliography submitted in the field of agriculture or the related sciences."

Ms. Langman is now doing bibliographic research for the Hunt Institute for Botanical Documentation, Carnegie-Mellon University, Pittsburgh, Pennsylvania.

The Mexican bibliography which was first published in 1964 at $25.00 a copy as a Morris Arboretum Monograph is now available at half price to individual purchasers.

BOOK REVIEW

PLANTS FOR MAN by Robert W. Schery. 2nd ed. 672 pp. 1972. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 07632

This very successful textbook on Economic Botany that first appeared twenty years ago, has undergone thorough revision. The new edition includes not only the up-dating of information on the species in the first edition, but also many newly important plants. It makes this volume an even more valuable work for use both as a textbook for students in economic botany and as a reference for botanists and people interested in plants in general.

After an introductory section on man's relationships with plants and man's economic interest in plants, the book presents the plants according to the type of products obtained—products from the plant cell wall: wood and fibers; cell exudates and extractions: latex products, pectins, gums, resins, oleoresins and similar exudates, tannins and dyes, essential oils, medicinals, insecticides, growth regulants, tobacco, oils, fats and waxes, sugars and starches; plants and plant parts used for food and beverage: cereals, other food seeds and forages, vegetables, fruits, beverage plants and "from microorganisms to miscellanea."

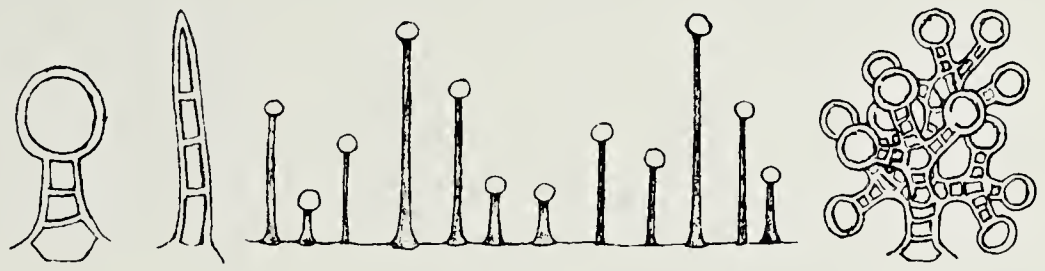
Both cultivated plants and wild plants of economic value are included. In each category, a few plants of major economic importance are elaborated upon. This is an especially commendable approach as such treatment provides an understanding of that particular plant-based industry and at the same time avoids a tedious review of a lengthy list of plants that are lesser sources of raw material. However, condensed listings of these less widely used sources are also given, more for reference than for study. Because of this, the book is a fairly voluminous one, yet it is not too ponderous for use as a textbook and at the same time is still comprehensive enough to be used as a reference work.

H. L. Li

ROSE SIGNATURES

drawings and text by

LEÓNIE BELL



We are pleased to publish this article by Léonie Bell because it illustrates that a devoted amateur may still make significant contributions to botany and horticulture. Many amateurs have truly intimate knowledge of some plants, but rarely reconvey it eloquently to professional botanists or other gardeners. Léonie Bell has not only gained such knowledge about old roses but is sharing it with an important group of rose enthusiasts who are trying to collect, and correctly identify, old varieties before they become extinct.

The genus *Rosa* has a dreadful reputation for inconsistency. The very ability of its species to interbreed that has given us roses of color and form hardly dreamed of a century ago has produced combinations of specific characters that seem at times entirely without pattern. John Lindley, who in 1820 published the first book on the species alone, having little regard for the garden kinds that Andrews and Redouté loved, claimed that "Pubescence on branches, peduncles, and tube of the calyx, is the only invariable character I have discovered in roses."

He had a point, yet there is more to go by than mere pubescencé. By that term I think he meant, rather, excrescences, or all those growths that can protrude from the green parts of a rose, from single-celled glands to tremendous prickles. They do occur in consistent patterns, but they alone are not sufficient for identifying a rose. Aside from the obvious means, leaves and bloom, other areas of rose anatomy are extremely important, for example, the receptacle, sepals, and stipules. With modern roses, Hybrid Teas, Floribundas and so on, bloom and foliage are everything, but with nineteenth century roses and the species, identification is possible without fresh bloom from the upper 10 inches of blooming stem alone. Identification? No, perhaps that is too demanding a word and applies when a rose is usually already known. But recognition of its class, yes.

[1] We thank the *Rose Annual* for permission to publish this revised and augmented version of an earlier article.

In those preciously few days of June when we search out old roses, it is possible to learn to recognize a plant as one we have seen before and have collected, even though only enough bloom remains to indicate relative color, by its own distinctive pattern of like parts. I call this the signature of a rose. Considering the limits of variation of our own written signatures, I have found that of a rose to be wondrously, startlingly, consistent. In fact the only time it fails to hold true is when the rose sports vegetatively—as has my lovely thornless 'Reine des Violettes' that produced the same foliage and bloom from thickly prickled wood!

Learning to recognize rose signatures requires much taking of notes and this in turn calls for an easy familiarity with the botanical terms that apply to roses. Often it is not necessary to use strictly botanical Latin- and Greek-based words, for others may be more quickly comprehended, but their meanings are good to know because they are precise and define in one word what might take many words in lay language. If at times they seem tauntingly vague, that is because they are not meant to apply solely to *Rosa.*

Let us begin with those excrescences, since they are present in some form on every rose. The most pleasing are glands—round single cells, stemmed or not, or a short string of elongated cells composing a glandular hair—because they secrete aromatic substances that make handling certain roses such a sticky, fragrant experience. In *Rosa eglanteria* they crowd every part of the leaf; in *R. centifolia* they are

clearly visible on the buds and pedicels; while in 'Common Moss', red globules tip the branches on translucent green treelets, forming the "moss" with its brownish cast. *Stipitate* glands are those on short firm stalks; *hispid* describes those tipping something a bit harder, longer, a bristle.

Prickles is the proper alternative to what we have always called thorns, and they come in great variety. From thin to thick, they range from a *bristle* (stiff hair of varying length) to the *acicular* prickle (needle-shaped) to the *subulate* prickle (awl-shaped, with base beginning to widen slightly) to all sizes and degrees of slant of the more usual rose thorn.

Sighting the axis of a rose prickle is the first step to drawing it. Some are straight or horizontal; others

have a pronounced hook; while some that actually slant upward, are *ascendant.* A few are so dilated at the base that, on the wood, they are taller than wide. I find prickles the most difficult anatomical part of a rose to draw, to get exactly right. They are problems in geometry, combinations of arcs and angles that are often indescribable botanically. Certain roses have the whole gamut of pricklage, yet their larger thorns have in common a like degree of slant.

Positioning of prickles is important. They can occur at each node, flaring out below either edge of the stipule, hence *infrastipular.* These are found in many species. *R. multiflora*, *R. bracteata*, *R. tomentosa*, *R. cinnamomea*, and many of the American wild roses have them and pass along this character through one or more generations of hybrids.

Pubescence, a nap of short hairs, is found on the armature of a single species, *R. rugosa*, but this softness does not succeed in making any part of the stems easier to handle! It disappears from mature prickles, and I have never found it in any of the many first generation Rugosa hybrids.

Prickles vary in color almost as much as do roses themselves. When new they may be pink, yellowish, tan, or many tints of green. With age the tones deepen to translucent red or to maroon, buff, brown, black, gray. Or they may simply fall off. Sometimes prickle color is the one easily spotted means of telling two similar roses apart.

Then the new basal growth may be thick with prickles, which decrease in quantity with the height of the cane. (In some instances the only way to determine the specific parent in an out-of-bloom plant of an F_1 hybrid is to check the lower armature of the new canes.) Often the flowering laterals may have no prickles whatever, or the reverse may occur, that the cane may be smooth and the blooming shoots will display the tell-tale prickle pattern. Whatever the case in each species or hybrid or clone, the behavior remains consistent, to be learned with observation and time.

Rose leaves are what is called *compound*, made up (in this genus) of an odd number of leaflets sharing a common stem or *rachis.* The part from the lowest

pair of leaflets to where it joins the stem is the *petiole*, a term commonly used for the whole axis, yet in *Rosa* the two lengths should be differentiated. The rachis is often armed beneath with a fierce set of prickles of its own. In fact, though the wood of *R. pendulina* has only a prickle here or there, its leaves have so many along the rachis that the plant is not one to brush past harmlessly. Mrs. Keays felt that such hooks even on to the midrib of the end leaflet indicated that a rose was a Noisette, but I have found them there in many other roses. This was the part, too, which she often described as "channeled like a Tea," a phrase that confused me for years because, actually, every rose rachis is channeled to some extent.

What is most interesting about the rachis, peculiar to each leaf of certain roses, is the bend it takes between the uppermost pair of leaflets and the end one, giving the last leaflet an upward or sideways slant. Sometimes there is an easily felt thickening of the tissues at the joint that resembles an elbow. The leaflets themselves can be stemmed, *petiolulate*, or if they fit snugly against the rachis, *sessile.*

At the base of the petiole and bordering it along either side is that fascinating bit of greenery, the *stipule.* We depend upon it to tell us much about a rose, yet with certain roses the variation in width, shape, and behavior of the stipules can be so bewildering that, alone, they offer only the vaguest clue to

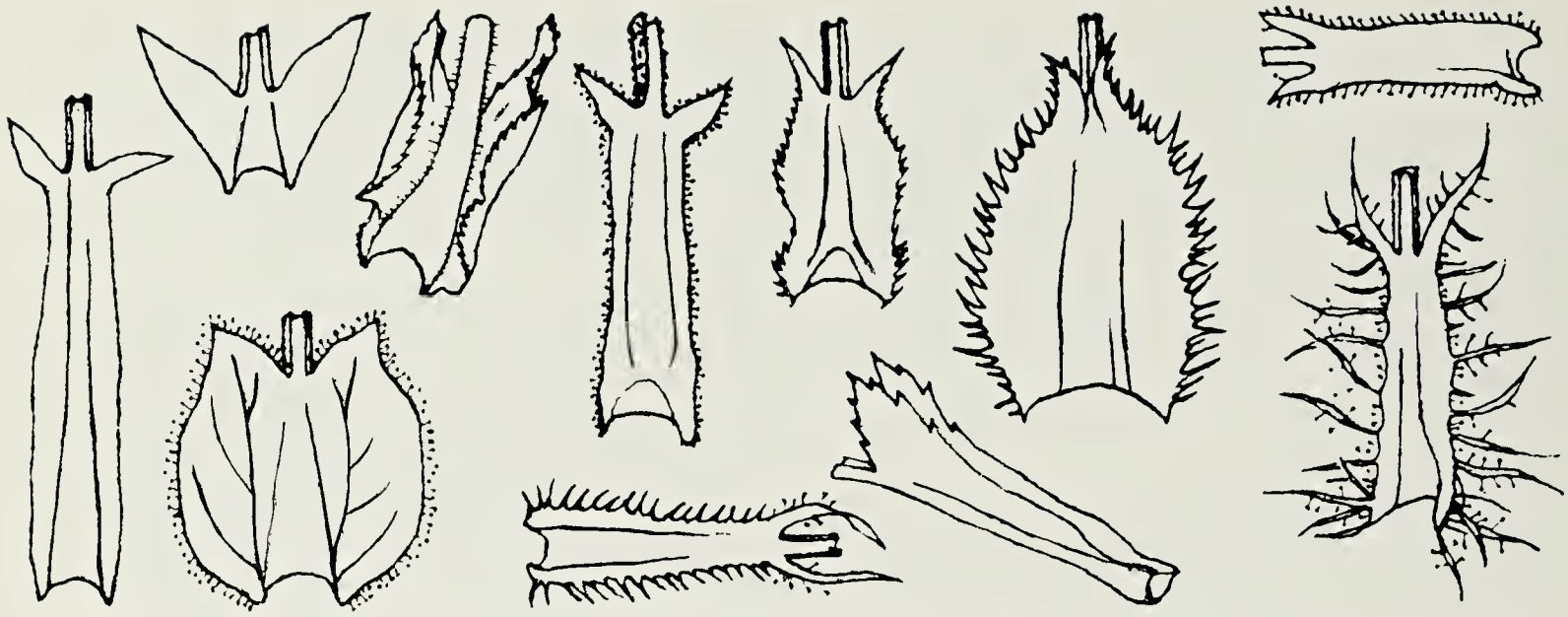
identity. Such a rose must be grown and observed for several years before the variation takes on a recognizable pattern, by which time other aspects of the rose help to fix its signature. 'Celsiana' provides an intriguing example. Along its laterals, proceeding from cane to inflorescence, can be found every width of stipule, from the very narrow with long slender *auricles* or upper tips, to ones so *dilated* or spreading that they appear round, with broad triangular auricles. Their edges can be either *recurved*, bend downward, or *undulate* with a ruffled appearance, or again, simply held on a plane.

The term *adnate*, often used to describe rose stipules, causes confusion. It is a relative word, meaning the length of the stipule that is actually joined to the petiole, while the remainder, the tips, are *free*. If used at all, some proportion between the two should be decided upon, which is difficult where extremes exist. *R. gallica* and *R. carolina* have the slender stipules that typify adnateness. On the laterals of many of the old roses, stipules tend to widen as their leaves approach the blooming end.

The edges of the stipules offer such important information that you had better use a hand lens to examine them. They can be *entire* and smooth-edged, or entire and gland-edged. They may be toothed, *dentate*, or if very finely so, *denticulate*. As indentations between the teeth deepen, the edges become either *pectinate* (comb-like) or *fimbriate* (fringed) with implied unevenness. When the extensions are so deeply cut and divided that they appear slashed, they are then *laciniate;* this is really a subdividing of the extensions into *pinnules*, in the branching way of ferns. Any of these degrees of toothing can be glanded as well.

There remain the leaflets themselves. Rose leaves rate a greater variety of botanical adjectives than any other part of the plant, yet few succeed in conveying, concisely, a clear idea of the foliage. More often it is the way the leaves present themselves or are carried on the wood, that supplies the identifying clue. The essential groundwork in rose identification involves learning what the species look like, particularly those known in Europe about mid-nineteenth century. Here are the parents of most of our garden roses. Once you recognize them you begin to spot their presence in hybrids. There are still so many old roses growing in this country, unnamed, waiting to be re-discovered, that, if their exact identities elude us, it become possible at least to deduce their ancestry.

Short of describing leaflets of individual roses, a chore not to be attempted here, there are key words to know. Rose leaflets without exception are toothed, some shallowly, others deeply, and the teeth have certain shapes. Most are *serrate* with teeth that point forward; on close examination the obvious large



teeth can be sets of two or three small ones, as happens in *R. centifolia.* Some have *crenate* or rounded teeth: *R. damascena bifera* has these, each one ending in an abrupt, *mucronate*, tip. In *R. rugosa* the smooth small crenations hardly show for they roll under, becoming *revolute.* Toothing that points outward is *dentate;* among my many roses I can find true dentation only on *R. alba* and its several close forms.

Though there are extremes, the great majority of rose leaflets are some kind of oval: if broadest across the lower half, *ovate* or egg-shaped, or if so across the outer half, *obovate. Ob-* is used before many terms and inverts their meanings. An ovate leaflet can have a broad, flat, *obtuse* base or one that is *cordate*, often with the rounded segments overlapping. Obovate leaflets are likely to have a *cuneate*, wedge-shaped base, often without teeth.

With the addition of the genes of *R. chinensis* came *elliptic* leaflets and ones with tapering or *acuminate* ends; came, too, the smooth, *glabrous*, often shining surfaces that are usual now in Hybrid Teas but which could once be seen only in isolated species like *R. bracteata*, *R. moschata*, and *R. sempervirens.* The presence of China blood shows strongly in the old class of Hybrid Chinas, the Noisettes, then the Bourbons, and later in the Hybrid Perpetuals.

The old European garden roses have other textures. *R. gallica* and *R. damascena bifera* have leaflets softly woolly, *tomentose*, beneath; those of the Gallica are leathery, *coriaceous*, deep green, while the Damask's, with a faintly silky covering above of flattened hairs, are *pilose.* The leaves of *R. alba* have a powdered surface, called *glaucous*, that can be rubbed off. Others can feel as crackly as a good bond paper, or so thin as to seem without veins, or so heavily netted beneath with veins that the upper surface becomes lumpy, *rugose.*

You must be cautioned when studying the foliage of a rose, particularly of those that bloom in June only, that the leaves on the new basal growth are often subtly different from those on the flowering laterals, the most obvious distinction being an extra pair of true leaflets.

Now at last we approach the inflorescence. Botanists when they make a key of *Rosa*, begin with the very center of the flower, its sexual organs, then proceed to other telling parts. I have begun with the wood and prickles because these are present when the flowers are not. Rose bloom is a long story, rose-slicing an intriguing exercise, but they must await the telling some other time. With the inflorescence we have problems enough.

Again and again in "botanies" and "floras" one reads that roses bloom in corymbs. This is an easy word to say, almost as easy as cluster; I have used it myself for years, yet it is apparently incorrect. In a *corymb*, a broad more or less flat-topped arrangement, the *outer* buds open first. With roses of every kind I have seen, the central bud opens first, and if there are attending clusters, *their* central buds open first.

Even if the arrangement is so dense that the short flower stems, *pedicels*, appear to emerge from one spot and so be *umbellate*, it is not. There will still be a primary, central bloom and its pedicel will lack bracts, while each of the other pedicels will occur in receding order, each with a pair of bracts or the scars left by ones that have fallen off. This is true of such tight-clustered kinds as *R. rugosa*, *R. damascena bifera*, and of many of the American species.

So roses bloom *cymosely*, with the central, *determinate* bud opening first. A true *cyme*, similar to a corymb except for the order of bud-opening, can be seen in the form of *R. moschata* currently distributed as 'Nastarana', and also in some of the early Noisettes. When the inflorescence is large and diffuse, it becomes a *cymose panicle.* The flowers of *R. banksiae* are said to be truly umbellate—and certainly odds

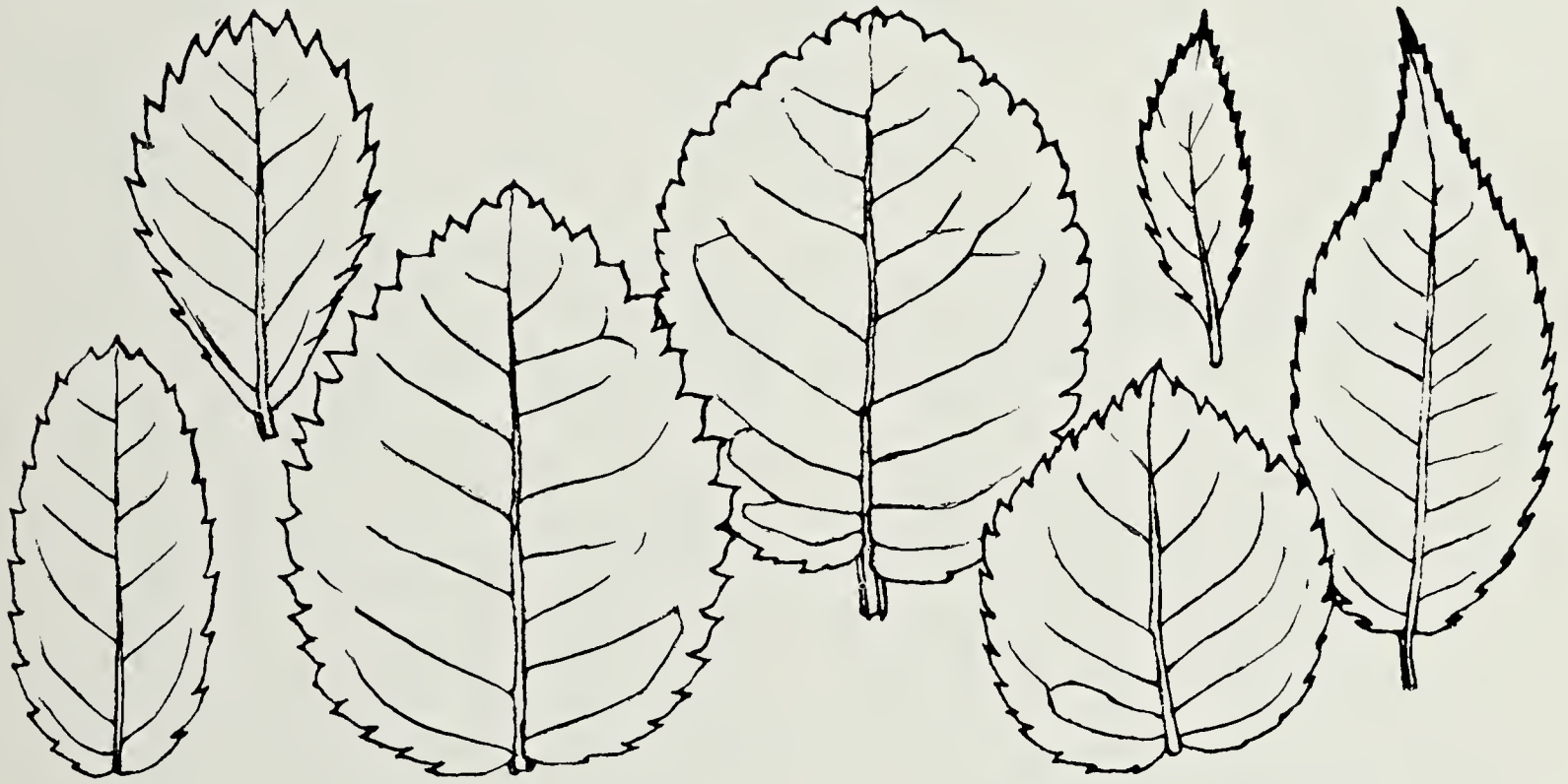
and ends of Perpetual Damasks and Hybrid Chinas appear to be—but if bracts are present, they are cymose.

Bracts are the leaf-like appendages near the lower end of the pedicel. They usually occur in pairs and can be gland-edged or plain. Some are minute, or fall off before we notice them; others are *lanceolate*, strap-like. They resemble a stipule, and lower ones may include a miniature leaflet or three. Two species, *R. bracteata* and *R. multibracteata*, have so many broad bracts beneath their buds that the character has given them their specific names.

An area that causes confusion is the *peduncle*. In a cluster it is the primary length of stem between the last complete leaf and where the branching of pedicels begins—often non-existent. Only when it supports a solitary flower does it become obvious and important. Pedicels and peduncle may be smooth or sport a pattern of glands or bristles that never varies in the one plant (Lindley's "pubescence").

The rose bloom rests on what is often called the calyx-tube, but which is more appropriately named *receptacle*. It contains the bottoms of the carpels, the ovaries. Once fertilization has occurred, the whole thing begins to change radically. The ovaries enlarge as the seeds develop inside and the fleshy, enclosing receptacle itself helps make up the hip, the fruit of the rose. While searching in Ellen Willmott's *The Genus Rosa* for material to amplify my own ideas about the receptacles of roses as they appear in bud and bloom, I was astonished to find that she described and had illustrated only the hips. I have watched the speed with which fertile roses can develop hips and their sometimes amazing change in shape: hip design is often irrelevant to the shape of the young receptacle. Most very double roses do not produce hips anyway. There seems to be no study, illustrated or not, of rose receptacles at *flowering* time, nor any attempt to make clear the terms applied to them. I solve the problem for myself by making drawings on the cards of my rose notes, but eventually the shapes need to be named.

Receptacles that splay out, without swelling or convex curve of any kind, have been called conical or cone-shaped. They are actually *obconical*, with the apex downward. Mrs. Keays called these "funnel-formed," a good word. The expression *turbinate* has caused me much grief over the years. One glossary defines it as "top-shaped; inversely conical." But, what shape top? It appears to be a catch-all term to describe any receptacle broadest at the summit, without constriction, that tapers down to the pedicel with a slight outward curve. Many roses have such an underpinning. It has been confused in French texts with "turneps" or turnip-shaped, which is a much broader, shallow construction like the lower half of a purple and white turnip.



Some, still broad at the top, have more or less parallel sides: one kind resembles a countersinking bit or drill; another is Mrs. Keays' "thimble-shaped," sometimes constricted midway with a waistline. Those that are *hemispherical* or cup-shaped join the pedicel abruptly, with no taper.

Pear-shaped or *pyriform* is another vague adjective; pears have such various silhouettes. The swollen 'Duchesse of Angouleme'? The ogee of the 'Bartlett'? The slender-tipped 'Beurre Bosc'? You can appreciate

now that the rose student must rely greatly on his own descriptive vocabulary and sketches. I did learn that the pear in this instance is stem end down, but the prefix *ob-* is not used. A pyriform receptacle is broad with some constriction below the sepals, then tapers to the pedicel.

Ovoid and *globose* are obvious. *Sub-globose*, applied to receptacle or to mature hip, means almost round but slightly broader than long, while *depressed-globose* is practically squat. When a receptacle *is* what we might call "pear-shaped," stem end up, with broad bottom and very constricted top, it rates the word *urceolate*, regardless of your own idea of what an urn looks like. *Fusiform* is a useful adjective because many rose receptacles have the spindle form or a variation of it: a basically slender shape, almost as narrow at the top as at the pedicel, modestly bulging through the center.

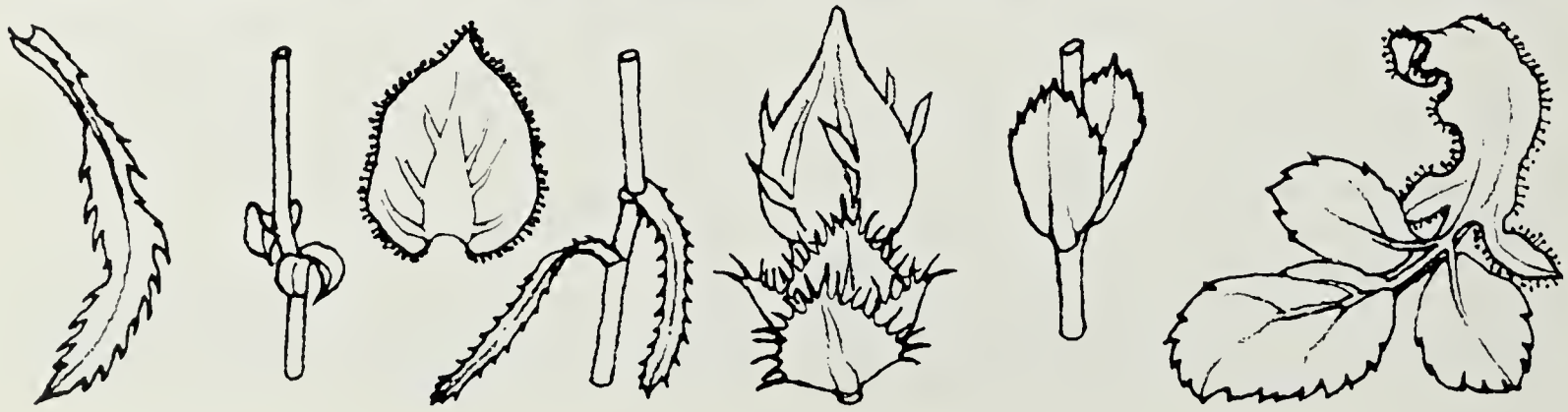
Some roses appear to have no receptacle at all, so narrow and straight-sided is it, perhaps the diameter of two stems. *R. damascena bifera*, the prototype of Perpetual Damasks, has one so tubular that we wonder there can be room for carpels, yet the plants here matured a number os shining red hips this summer.

Where it is possible to observe one species from its single form through several degrees of doubleness, the receptacle increases in width in proportion to petallage, but only as a support, not as a container of more carpels. The hips of most very double roses are full of chaff. In instances of extreme foliation of the sepals there can be no receptacle at all, an overcompensation first noticed by the French botanist, Thory, of *R. centifolia foliacea*, but more readily seen now in *R. chinensis viridiflora* which has only a token swelling beneath its jade rosettes.

Sepals, whether elementally plain and only large enough to cover the young bud, or so long and ornate that the bud alone is a thing of great beauty, are always interesting, full of secrets and contradictions.

Strangely, the word *sepal* came into use as recently as 1790. While five *calyx-lobes* (its synonym) are the rule, a few hybrids have six, scven, or eight, so the number is worth noting. Shape is not; how much can the outline of five enclosing segments vary to matter? But length is important, and, of course, whether or not they are ornamented.

Most sepals are *attenuate*, slender, tapering to just beyond the petal mass. If the tips narrow abruptly to



a firm point, they are *cuspidate.* Clones close to Tea, China, and Gallica are likely to have a minimum of sepalage, unadorned. If long, drawn out, then widening at the ends, they have become *dilate; R. virginiana* and *R. carolina* provide examples.

When sepals sprout appendages as in Edward Bunyard's "wings," these occur in many forms. They can be mere threads, or broad and numerous, or even divided again and so, *foliaceous.* Alba, Damask and Centifolia roses have well-deserved reputations for beautiful buds, made so by this green exuberance. Though Gerarde and Parkinson overlooked them altogether, others of their time must have appreciated their design for Bunyard quotes this charming medieval riddle:

> *"We are five brothers at the same time born.*
> *Two of us have beards, by two no beards are worn,*
> *While one, lest he should give his brothers pain,*
> *Has one side bearded and the other plain."*

This same decorative arrangement happens not only on the sepals of the oldest European garden roses but on those of all that are *pinnatifid,* of whatever origin. *Compound* and *composite* mean the same thing, for the reference is to the *pinnae* of a fern frond. Few nineteenth-century rose observers paid heed to sepals. Lindley did; Thory (in Redouté) only when they were extraordinary; Mrs. Gore (after Boitard) indicated more that were noteworthy.

In rose anatomy, generalizations about the sepals and their foliations are hard to make, this area can vary so from clone to clone in any given class. Among Perpetual Damasks, Hybrid Perpetuals, and now Hybrid Teas, one can find anything from lobes plain and simple to others so long and complex that they are veritable leaves.

'Crested Moss' is not mossy in the true glandular sense: the borders of its sepals are simply massed with folded wings. Even on the same plant, judging by sepals alone, the set on the last bloom in a cluster may bear only a superficial resemblance to that of its first. The central bud is invariably the most ornate, while successively opening ones grow less so.

Here is one reason why casual photographs of roses are seldom adequate aids to identification: they are taken of that first sumptuous flower which completely hides the sepals. Mrs. Keays photographed the reverse of some of her roses. This was effective when the blooms were not very double or the sepals didn't reflex.

Sepals have mannerisms of movement that form another part of a rose's signature. With *R. centifolia, R. tomentosa,* and to some extent in *R. gallica,* they remain spread out during blooming and afterward, when the petals have shriveled, making a lovely starry pattern. Those of most other roses, however, *reflex,* bending down alongside the pedicel. This happens very obviously to the sepals of *R. alba, R. damascena,* and many American species, but with China, Tea, and modern roses there is every gradient of bend between. The position of sepals is worth examination and notation, especially in the early Hybrid Perpetuals, in which many spread out as if to support their heavy, many-petaled blooms. If the rose sets fruit, the sepals of some persist, ascending or even converging; others typically fall off quite early.

Sepal lobes can have the same assortment of excrescence that we find on pedicels and receptacles—glands that are either stipitate or hispid, or bristles without glands, or soft hairs over most of their outer surface or only along the edges. Again, they may be simply smooth, glabrous.

You see, there is so much more to a rose than its bloom. Getting to know the habit, the pattern, the *signature* of a rose takes patient observation and an openness of mind that allows for the surprises a rose is capable of springing on us over the years. One clone that has always been a moderate bush in an exposed situation may, when grown in a protected corner, reach climbing proportions. Another that has always had only semidouble flowers may in one year produce very double flowers. In long cool seasons roses that have never fruited may set a number of hips full of viable seeds. All this we take into account, but the basic signature is there season after season in the prickles and green parts of a rose.

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Index to Volume XXIII, 1972